CHAPTER 5

INFORMATION ABOUT THE DISTRIBUTION SECTOR

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5.1 BASIC INFORMATION ABOUT THE DISTRIBUTION SECTOR

5.1.1 Business Structure

Under the supervision of MoEW, EDL and the distribution service providers (DSPs), a wholly owned subsidiary of EDL, are responsible for planning, developing, and operating the distribution systems in most areas of Lebanon (Fig. 5.1-1). In some areas, Private Concessions are responsible for distribution business instead of DSPs.

In Lebanon, power supply by private power generators (Private Generators) which supply electricity when the EDL's power supply is unavailable, have become widespread due to the regular outages of EDL's distribution systems from the past (Fig.5.1-2). Recently, as the duration of EDL's system outages has increased, consumers have become increasingly dependent on power supply from Private Generators.

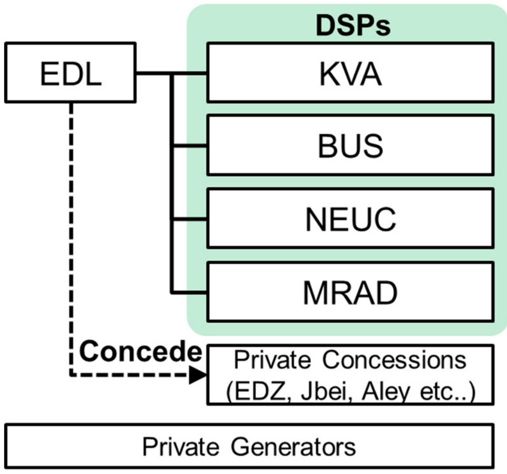
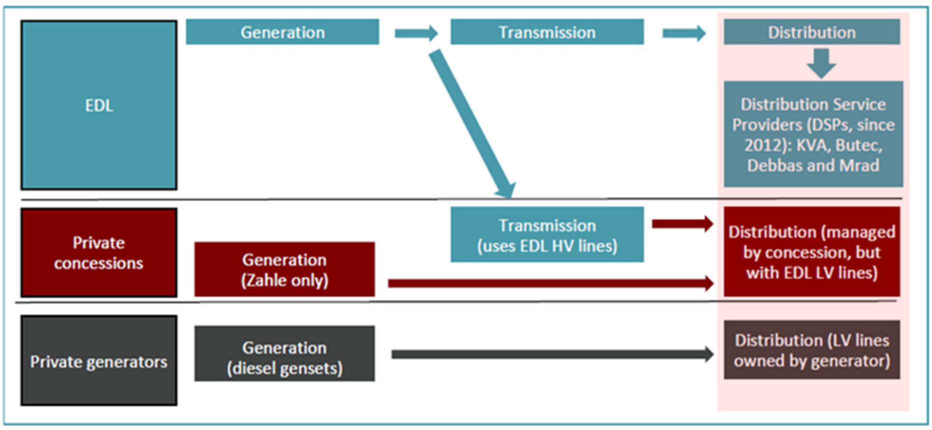


Fig. 5.1-1 Structure of the distribution business



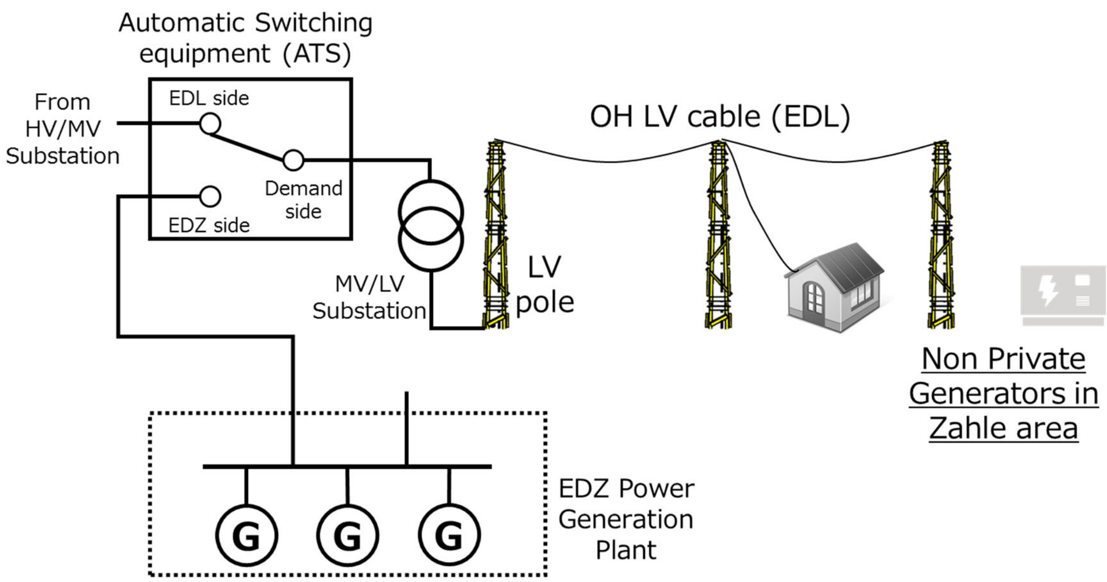
Source: The politics of reform in Lebanon's electricity sector

Fig.5.1-2 Electricity business structure

5.1.2 Private Concession

In some areas of Lebanon, EDL entrusts the distribution business to Private Concessions such as Electricite de Zahle (EDZ), Jbeil, and Aley. Among them, EDZ has been entrusted by EDL with planning, maintenance, and operation of distribution systems since 1927. The role of EDZ as a Private Concession is legally guaranteed. EDZ has approximately 200 employees. Within the EDZ area, electricity is supplied 24 hours a day by EDZ and the quality of electricity is high. Therefore, there are no Private Generators within the EDZ area as there are in other areas of Lebanon.

EDZ supplies electricity when EDL systems are outage in addition to maintaining distribution facilities and collecting tariffs as well as DSPs. EDZ owns diesel generators which are connected to EDL MV distribution lines (Fig. 5.1-3). When an EDL system is an outage, the generator of EDZ starts and supplies electricity to the MV distribution line. Therefore, the general LV customers do not require power supply from Private Generators, and the customer's drop line is one line. This is different from other areas in Lebanon where consumers have two drop lines, one from EDL and the other from a Private Generator.



Source: JICA consultant team

Fig. 5.1-3 Facilities of Private Concession

EDZ has introduced a unique meter to distinguish between EDZ's power supply and EDL's power supply, and has already completed its introduction to 15% of LV customers. The meter has two indexes, EDZ and EDL. EDZ transmits the classification of the metering time to the meter via remote communication. Previously installed conventional meters do not distinguish between EDZ and EDL. At the location where the conventional meter is installed, after the total amount is metered, the metered value is prorated according to the ratio of EDZ supply duration to EDL as recorded by EDZ.

The distribution loss of EDZ is about 5% of the total of technical loss and non-technical loss, which is much better than that of DSPs. The electricity revenue to EDL from the low non-technical losses of the EDZ is significant. As a comparison for areas adjacent to EDZ, KVA, one of the DSPs, is responsible for the capital Beirut and the eastern Lebanon area surrounding the EDZ area. Although KVA's eastern Lebanon area is much larger than EDZ area, EDZ generates more revenue for EDL than KVA when comparing the revenue generated by both area. EDL considers that this difference is due to their attitude towards non-technical losses and the results of their activities.

Table 5.1-1 Comparison of the performance of EDL and EDZ in Zahle area

	EDL	EDZ
Supply reliability	Periodical power outages	24/7
Electric power quality	Stable voltage	Stable voltage
Quality of service (Customer response and replacement)	Low	High
Technical loss	About 16%	About 5%
Rate of collection of electricity tariff	~70%	~100%

Source: The politics of reform in Lebanon's electricity sector

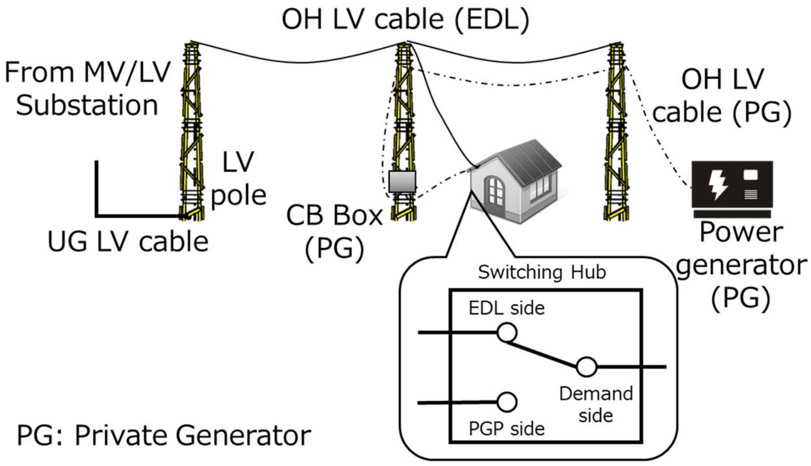
Based on the comparison of DSP and EDZ (Table 5.1-1), MoEW and EDL consider EDZ as a successful case and assume that the same method as EDZ will be rolled out in other areas of Lebanon. However, there are concerns that this will be politically difficult, as strong objections are expected not only from DSPs, but also from Private Generators, which are prevalent in Lebanon. The success of the EDZ is also due to the safety of the area of EDZ and the profitable contract between EDZ and the EDL. In particular, since the level of security varies greatly from area to area, simply changing the contractual structure of DSPs to be similar to that of EDZ may not produce the expected results.

5.1.3 Private Power Generator (Private Generator)

Due to the decline of the Lebanese currency, EDL is having difficulty procuring fuel for thermal power generation. As a result, EDL implements a scheduled power outage that can only supply electricity to customers for up to four hours per day. Therefore, during power outages in EDL systems, many users purchase electricity from Private Generators or generate electricity with their own power generator. Private Generators supply electricity generated by diesel generators installed in town parking lot premises or apartment premises to LV customers via dedicated LV lines they have installed (Fig. 5.1-4). During the field survey, iPower Services was identified as the specific Private Generator and Khonaysser Motors as the generator manufacturer.

Fig. 5.1-4 Diesel generator (L: in parking lot, R: in apartment)

A total of two drop lines are installed at the premises of LV customers, one installed by EDL and the other by the Private Generator. At a customer's premise, an automatic switching hub for power supply is usually installed, and power is supplied by the Private Generator when the outage of EDL's distribution system (Fig. 5.1-5).



Source: JICA consultant team

Fig. 5.1-5 Facilities of Private Generator

In many cases, Private Generators' LV lines are attached to EDL's LV electric poles without permission (Fig. 5.1-6). The location of Private Generators' LV lines on electric poles is often below the EDL's LV line. Because several Private Generators sometimes install LV lines on a LV pole, the LV lines are often congested. EDL is concerned about the higher risk of electric shock when working on such low-voltage poles.

Fig. 5.1-6   LV pole in Beirut City

The supply contract between a Private Generator and a consumer is generally divided into two types: metered and flat-rate. Meters for metered type and breakers for flat-rate type are often installed on LV poles of EDL or on the wall of the customer's building (Fig. 5.1-7, Fig. 5.1-8). The electricity tariff of Private Generator is higher than that of EDL, but in order to have a stable electricity supply, consumers need to contract with Private Generators.

Fig. 5.1-7 Facilities of Private Generator

Fig. 5.1-8 Breakers and Meters of Private Generator

5.1.4 Power Loss Caused by Distribution Facilities

Significant power losses occur in EDL's transmission and distribution facilities. In 2021, the total loss on transmission and distribution facilities was 40.2%, which is higher than that of neighboring countries. Among them, the technical loss on distribution loss was 13.2% and the non-technical loss was 26.9% (Table 2.2-2). The power loss is calculated from measured values of the meters installed at the HV/MV substations, MV/LV substations, and the customers.

Transmission loss = Σ (measured value at HV/MV substation)-Σ (measured value at MV/LV substation)

Distribution loss = Σ (measured value at MV/LV substations)-Σ (measured value at customers)

To classify distribution losses into technical and non-technical losses, the consultant's classification in an EDF project around 1995 is still used today.

In Lebanon, efforts to reduce particularly large non-technical losses are the urgent issues. Therefore, measures to reduce non-technical losses are underway such as a campaign to remove illegal connections and the advanced metering infrastructure (AMI) program. (Table 5.1-2)

Table 5.1-2 List of issues and major efforts to reduce non-technical losses in Lebanon

Issues	Initiatives	Place of responsibility	Implementation period
(1)Remove illegal connections	Campaign to remove illegal connections (including security guards and legal backups)	MoI - MoJ - MoD - MoEW - EDL - DSPs	2022-2023
(2)Properly collect electric tariff	Implementation of AMI program (introduction of smart meters, deployment of AMI center, etc.)	MoI - MoJ - MoD - MoEW - EDL - DSPs	2022-2024

Note: MoI: Ministry of Interior, MoJ: Ministry of Justice, MoD: Ministry of Defense
AMI: Advanced Metering Infrastructure

Source: JICA consultant team

The following are examples of specific methods of power theft that were informed by EDL.

- Theft from a pole transformer in overhead areas

  Connect an illegal wire to the conductor inside the LV distribution board.
- Theft from the LV trunk line between LV poles in the underground area

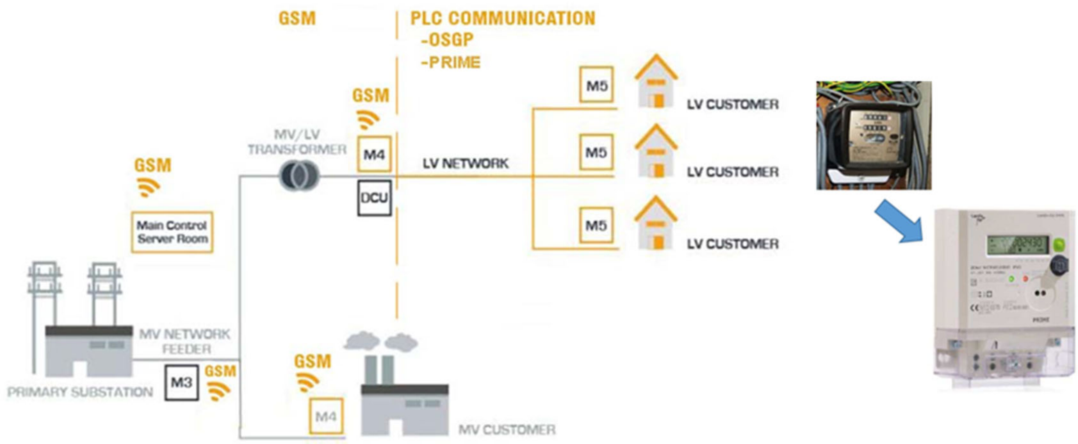
  Insert a metal needle through the sheath of LV trunk line to the inner conductor, and connect the illegal wire to there. Or, connect the illegal wire to the exposed metal connection component at the connection point of the EDL's regular drop line to the LV trunk line.
- Theft from apartment houses

  Connect an illegal wire to the circuit on the power supply side of the meter at the place where the meter is installed.

If an illegal connection is found, it is to be removed with the help of the DSP based on the judgment of EDL. However, due to the shortage of EDL personnel and the complicated cooperation between EDL and DSP, it is not being carried out smoothly at present.

5.1.5 Outline of AMI Program

AMI program aims to reduce power loss and improve load management operations by optimizing billing and collections. Smart meters are important to AMI program. The plan is to remotely aggregate metered indexes from smart meters installed at customer premises to EDL's AMI central unit (Fig. 5.1-9). This is expected to significantly reduce the labor required for meter reading by DSPs. It is also expected that the smart meter has a built-in switchgear and can remotely shut down the power to unpaid customers.



Source: EDL website

Fig. 5.1-9 Image of AMI program

EDL expects AMI to streamline operations, but the EDL’s shortage of the budget and engineers has delayed in the installation schedule of AMI central unit. Therefore, smart meters installed before the installation of AMI central unit are not fully utilized. In addition, since EDL headquarters building was destroyed, finding the location for AMI central unit is also a critical issue for promoting AMI program.

5.1.6 Smart Meter

Approximately 1.1 million smart meters are planned to be installed throughout Lebanon. The installation targets are classified into M1 (power plant bus lines), M2 (HV/MV substations), M3 MV distribution lines), M4 (MV/LV transformers and MV customers) (Fig. 5.1-10), and M5 (LV customers) (Fig. 5.1-11). The installation of smart meters from M1 to M4 has been completed, except for MV/LV transformers of M4 (World Bank, 2020). Since smart meters are the assets of EDL, DSPs install them with the necessary budget provided by EDL. However, in recent years, EDL has not had sufficient budget and the installation of smart meters by DSPs has been greatly delayed.

Fig. 5.1-10   L: M4-1 smart meter (KVA), R: M4-2 smart meter (BUS)

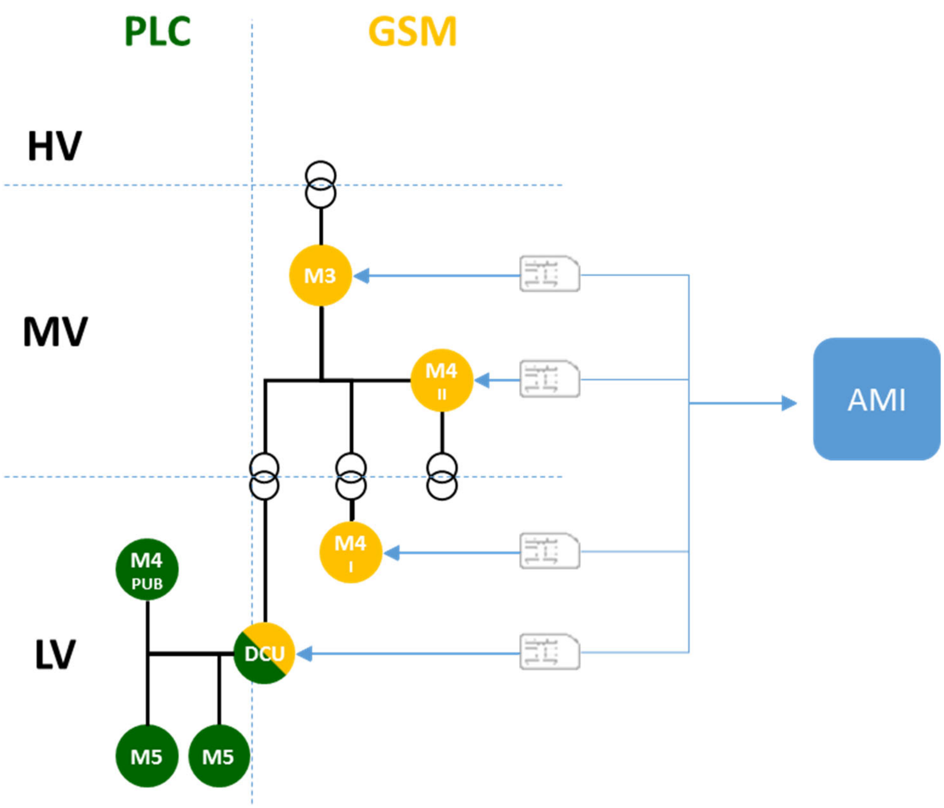
Fig. 5.1-11   L: M5 smart meter (KVA), R: M5 smart meter (BUS)

EDL standardizes the specification of the smart meter that DSPs install. DSPs develop or choose smart meters to be installed at customer's premises in accordance with the EDL standard, and they are installed with the approval of EDL. The functions of the smart meter to be installed by BUS, one of the DSPs, are shown below (Fig. 5.1-12).

1. Remotely shut down or turn on
2. Remotely read the meter indexes
3. Alert when external interference occurs
4. Grasp the current fluctuation
5. Identify defective parts on distribution lines
6. Acquire data on energy correlations among transmission substations, distribution substations, and consumers

Fig. 5.1-12 Smart meter installed in Lebanon (excerpt from catalog)

The smart meter uses the global system for mobile communication (GSM) or the power line communication (PLC) (Fig. 5.1-13 and Table 5.1-3). M3 and M4 except for consumers adopt GSM, and M4 for consumers and M5 adopt PLC. In case of PLC, the indexes will be aggregated to AMI central unit via GSM after being aggregated to DCU.



Source: EDL

Fig. 5.1-13 Smart meter and communication method

Table 5.1-3 Smart meter and communication method

	Voltage	Current	Current Range	Communication
M3 Meters	VT	CT	Above 100A	GSM-Daisy Chain
M4 Type II	VT	CT	Above 100A	GSM
M4 Type I	LV	CT	Above 100A	GSM
M4 Public	LV	CT	Above 100A	PLC
M5 3P indirect	LV	CT	Above 100A	PLC
M5 3P direct	LV	-	Up to 3x60A	PLC
M5 1P	LV	-	Up to 60 A	PLC

5.2 INFORMATION ABOUT DISTRIBUTION SERVICE PROVIDER (DSP)

5.2.1 DSP Project

In April 2012, MoEW launched the distribution service provider (DSP) projects to reduce technical and non-technical losses, modernize meter reading, upgrade distribution facilities, collect electricity tariffs, and improve customer service. When the DSP project was launched, it had a total of three companies: BUTEC Utility Services (BUS), KVA SAL (KVA), and the National Electrical Utility Company (NEUC). In 2018, MRAD Utility Services (MRAD) joined the project, and currently a total of four companies are entrusted with the distribution business from EDL. Each DSP has concluded the public private partnership (PPP) contract with EDL. The main scopes of DSP are shown below.

1. Investigation and evaluation of distribution facilities
2. Formulation of investment plans for facility improvement based on the investigation
3. Asset management related to the planning and design of distribution systems
4. Construction of facilities related to the reinforcement of distribution system
5. Maintenance and operation of the distribution system
6. Installation, trial, maintenance, and operation of smart meters
7. Meter reading
8. Collection of electricity tariffs
9. Reporting to the entruster (EDL)

The PPP contract was originally intended to establish and continuously evaluate Key Performance Indicators (KPIs) such as distribution transformer utilization factor, total distribution system losses, supply reliability (SAIDI and SAIFI), maintenance implementation rate, and average response time to customer inquiries. However, these have not been fully implemented and evaluated, and the current situation has not led to significant improvements in the distribution service. The PPP contract has been extended without major changes since it was first signed in 2012. For this reason, EDL hopes to revise the contract at the next contract renewal opportunity to contribute to improved distribution service.

Although the Lebanese currency has declined in recent years, EDL's electricity tariffs in its own currency had not been revised. This has greatly worsened EDL's financial condition and made it difficult for EDL to make USD-denominated payments to DSPs under the PPP contract. As a result, the DSPs that has no other stable business are in a difficult financial situation. Since 2023, EDL's electricity tariffs have been raised and denominated in USD. DSPs expect this revision to improve EDL's financial situation and stabilize payments from EDL to DSPs.

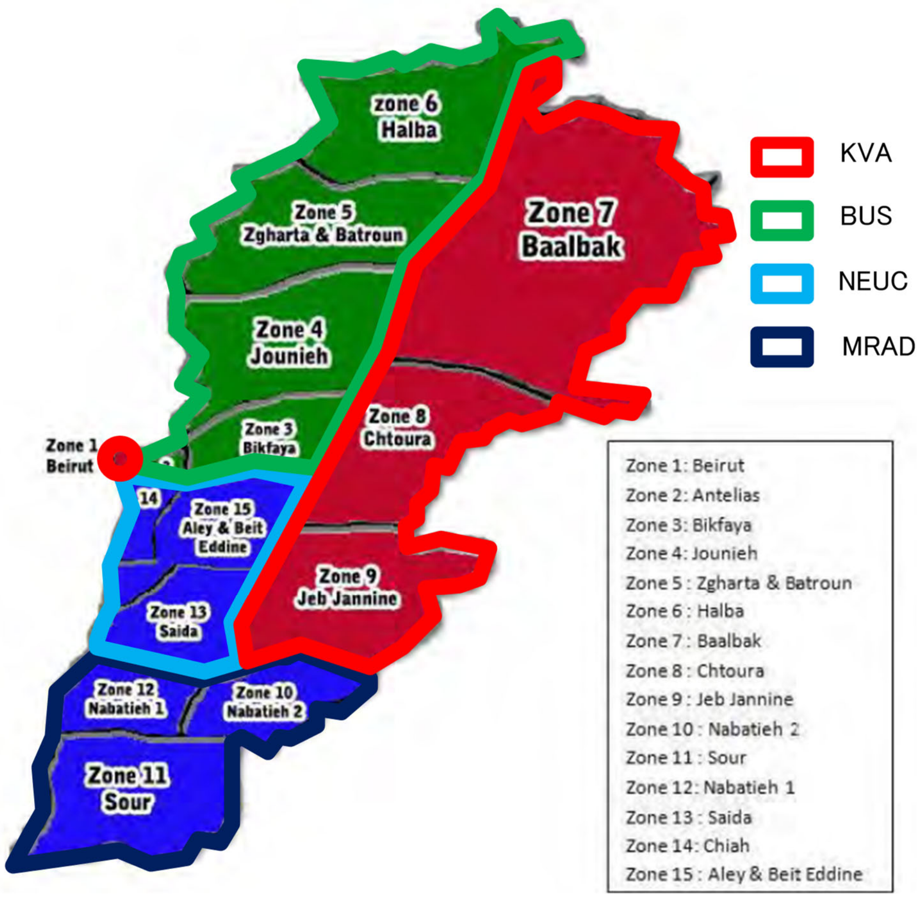
5.2.2 Areas for Responsible

In Lebanon, the distribution business is managed in zones, which are divided into 15 basic geographical units. EDL assigns zones to DSPs and entrusts the operation to DSPs. (Table 5.2-1 and Fig. 5.2-1).

Table 5.2-1 Zones responsible for each DSP

DSP	Zones responsible for
KVA	1,7,8,9
BUS	2,3,4,5,6
NEUC	13,14,15
MRAD	10,11,12

Source: EDL



Source: Editing JICA consultant Team Based on EDL Materials

Fig. 5.2-1 Areas of each DSP

5.2.3 Material Management

Each DSP stores materials for construction in its own warehouse (Fig. 5.2-2: L). After DSPs purchase the materials, they become assets of DSPs from the time they are stored in the warehouse until the construction is completed. After the construction is completed, the ownership is transferred from the DSP to EDL. Specifically, poles (Fig. 5.2-2: R), transformers, electric wires, cables (Fig. 5.2-3: L), temporary prefabricated substations (Fig. 5.2-3: R), etc. are stored in the warehouse. The temporary prefabricated substation is used during the construction of distribution substation.

Fig. 5.2-2 L: NEUC material warehouse, R: Electrical pole warehouse

Fig. 5.2-3 L: Drum of underground cable, R: Temporary prefabricated substation

5.2.4 KVA

Fig. 5.2-4 KVA headquarters

- Joined in business	2012 (11 years)
- Areas	Central Beirut and northeastern Lebanon
- Organization structure	2 Headquarters (Beirut Area (Fig. 5.2-4), other areas) 9 branches (Beirut 1, other 7 branches)
- Number of employees	About 550 About 350 engineers and sales representatives, and about 200 collectors
- Number of customers	About 330,000
- Education system	There is no training facility for distribution work in the company. Training for workers is basically conducted through OJT.
- Other	KVA's service office is located on the first floor of the EDL headquarters building in Beirut. As a result of the explosion at Beirut port, the original service office was destroyed and is no longer in use (Fig. 5.2-5: L). Currently, a temporary service office is located elsewhere on the first floor of the EDL headquarters (Fig. 5.2-5: R).

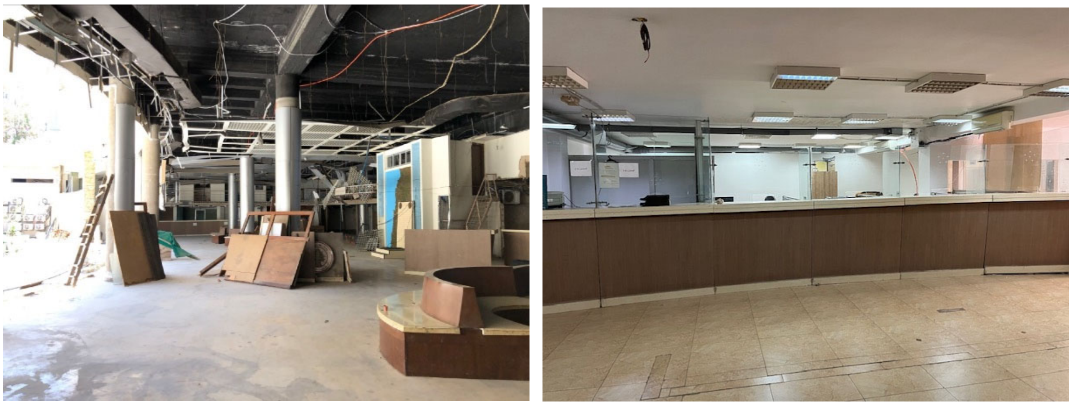


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Fig. 5.2-5 KVA service office (L: original, R: temporary)

5.2.5 BUS

Fig. 5.2-6 BUS headquarters

- Joined in business	2012 (11 years)
- Area	Northwestern Lebanon
- Organization structure	Headquarters (Fig. 5.2-6), 15 branches
- Number of employees	About 800
- Number of customers	About 500,000
- Education system	It has an overseas training system for all employees.
- Other	Approximately 40,000 smart meters, more than 10% of all meters, have been installed in BUS area. The installation rate is

the highest among four DSPs. However, since the financial crisis of Lebanon in 2020, the progress in installing smart meters has been delayed compared to before. BUS has its own central unit that enables remote communication and control of smart meters in its area.

5.2.6 NEUC

Fig. 5.2-7 NEUC headquarters

- Joined in business: 2012 (11 years)
- Area: Southwestern Lebanon
- Organization structure: Headquarters (Fig. 5.2-7), 5 branches
- Number of employees: About 560
- Number of customers: About 400,000 units
- Education system: It has training facilities for distribution work.

5.2.7 MRAD

Fig. 5.2-8 L: Building where MRAD headquarters is located, R: MRAD headquarters reception

- Joined in business	2018 (5 years)
- Area	Southern Lebanon
- Organization structure	Headquarters(Fig. 5.2-8), 10 branches
- Number of employees	About 620
- Number of customers	About 260,000
- Other	Since the branch offices are located far from the headquarters in Beirut, monitoring cameras are installed in warehouses and offices, and can be monitored in real time using the smartphone application. The current location of each vehicle can also be grasped on the map using the smartphone application.

5.3 INFORMATION ABOUT EXISTING DISTRIBUTION FACILITIES

5.3.1 Outline of Facilities

Fig. 5.3-1 shows an example of a single-line diagram of a distribution system. The HV system to which the power plant is connected is connected to the MV system, which is the primary distribution level, through the HV/MV substation. The MV distribution line is connected to the LV system, which is the secondary distribution level, through the MV/LV substation.

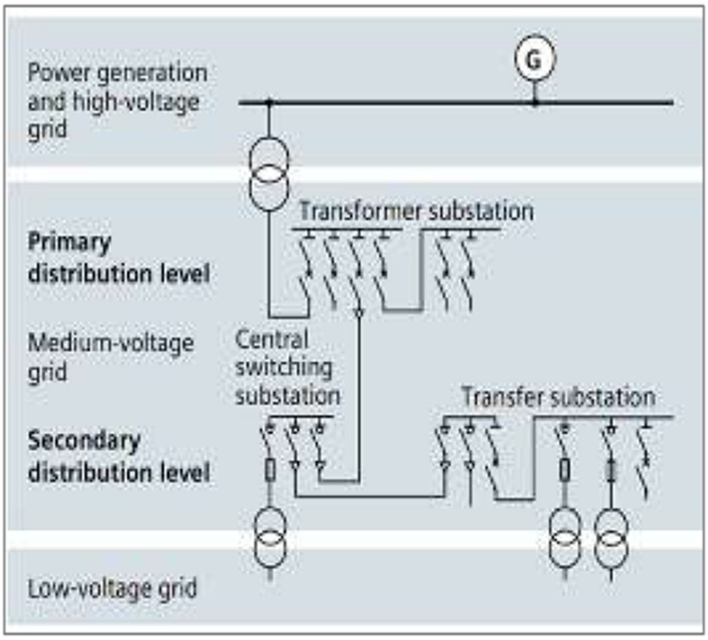


Fig. 5.3-1 Example of single-line diagram of distribution system

5.3.2 Voltage Class

Distribution facilities in Lebanon are classified into MV lines of 5.5kV, 11kV, 15kV, and 20kV, and LV lines of 380/220V. The MV lines are mainly operated at 11kV and 15kV (Table 5.3-1).

Table 5.3-1 Standard voltage of MV and LV distribution lines

Class	Voltage
MV distribution line	5.5kV
	11kV
	15kV
	20kV
LV distribution line	380/220V

Table 5.3-2 shows the statistics on distribution lines. While MV distribution lines are being moved underground, overhead lines for MV distribution lines account for 73% of the total, while underground lines account for 27%. Of the total LV distribution lines, 99% are overhead lines

Table 5.3-2 Statistics on distribution lines

Facility classification			Length (km)
Distribution line Span length	MV	Overhead	3,483
		Underground	1,282
	LV	Overhead	5,028
		Underground	70

Source: JICA consultant team

5.3.3 Wire Specifications

Aluminum wire and copper wire are used for the conductor of the wire. For MV overhead wires, bare wires and bundled cables are specified. On the other hand, for LV overhead wires, a bundled cable is specified.

Table 5.3-3 to Table 5.3-6 show the wire specifications by voltage class and by overhead and underground.

Table 5.3-3 MV overhead wire specifications

MV - OH LINES						
Conductor	Cross-Section (mm²)	R @ 20°C (Ohm/km)	R (Ohm /km) @60°C	Inom (A) Outdoor T° @ 30°C	Temperature de-rating Factor	Inom (A) Outdoor T° @ 40°C
ALMELEC	3x34.4	0.958	1.112	145	0.91	130
	3x54.6	0.603	0.700	190	0.91	170
	3x75.5	0.438	0.509	240	0.91	220
	3x94.1	0.3579	0.416	290	0.91	260
	3x117	0.283	0.329	310	0.91	280
	3x148	0.224	0.260	365	0.91	330
AL-STEEL	3x228	0.157	0.182	460	0.87	400
	3x147	0.243	0.282	345	0.87	300
Aerial bundled cable	3x70 + 16 + 50	0.443	0.514	226	0.91	210
	3x150 + 25 + 70	0.206	0.239	360	0.91	330
Bare copper	3x16	1.153	1.339	130	0.91	120
	3x25	0.728	0.845	160	0.91	150
	3x35	0.533	0.619	200	0.91	180
	3x50	0.381	0.442	250	0.91	230
	3x70	0.27	0.314	310	0.91	280

Table 5.3-4 MV underground wire specifications

MV - UG CABLES						
Conductor	Cross-Section (mm^2)	R @ 20°C (Ohm/km)	R (Ohm /km) XLPE /PVC: @60°C PI : @ 55°C	Inom (A) Soil @ 20°C AL @ 150°C cm/W CU (PI) @ 100°C cm/W CU (XLPE) @ 150°C cm/W	Soil Correction Factor = soil temperature * resistivity factors	Inom (A) Soil @ 25°C dry soil @ 150°C. cm/W
ALU (XLPE)	3x95	0.320	0.372	203	0.96	190
	3x150	0.206	0.239	259	0.96	250
	3x185	0.164	0.190	293	0.96	280
	3x240	0.125	0.145	338	0.96	320
	3x400	0.0778	0.090	432	0.96	410
CU (PI)	3x35	0.524	0.596	160	0.826	130
	3x50	0.387	0.440	175	0.826	140
	3x70	0.268	0.305	212	0.826	180
	3x120	0.154	0.175	302	0.826	250
CU (XLPE)	3x70	0.268	0.310	220	0.96	210
	3x120	0.153	0.177	298	0.96	290
	3x240	0.0754	0.087	431	0.96	410

Table 5.3-5 LV overhead wire specifications

LV - OH LINES						
Conductor	Cross-Section (mm^2)	R @ 20°C (Ohm/km)	R (Ohm /km) @60°C	Inom (A) Outdoor T° @ 30°C	Temperature de-rating Factor	Inom (A) Outdoor T° @ 40°C
Aerial bundled cables	3x25+ 54.6 + 16	1.2	1.393	111	0.91	100
	3x35 + 54.6 + 16	0.868	1.008	138	0.91	130
	3x50+ 54.6 + 16	0.641	0.744	168	0.91	150
	3x70 + 54.6 + 16	0.443	0.514	213	0.91	190
	3x150 + 70 + 16	0.206	0.239	344	0.91	310

Table 5.3-6 LV underground wire specifications

LV - UG CABLES						
Conductor	Cross-Section (mm^2)	R @ 20°C (Ohm/km)	R (Ohm /km) XLPE /PVC: @60°C	Inom (A) Soil @ 20°C AL and CU @ 100°C cm/W	Soil Correction Factor = soil temperature * resistivity factors	Inom (A) Soil @ 25°C dry soil @ 150°C. cm/W
AL	3x95 + 50	0.32	0.372	244	0.817	200
	3x150 + 70	0.206	0.239	312	0.817	250
	3x240 + 95	0.125	0.14515	408	0.817	330
CU (PVC)	4x70	0.268	0.310	227	0.817	190
	4x120	0.153	0.177	311	0.817	250
	4x240	0.0754	0.087	454	0.817	370

5.3.4 Distribution Substation (MV/LV)

Distribution substations in Lebanon refer to the facilities for MV/LV transformation. They are installed on poles mainly in overhead areas outside Beirut. On the other hand, in the underground area in Beirut, they are installed indoors.

(1) Overhead area

Outside Beirut city, distribution substations are installed on top of a pair of electric poles (Fig. 5.3-2 and Fig. 5.3-3). From top, MV distribution lines, arcing horns, lightning arresters, disconnecting switches, MV fuses, LV distribution lines, a transformer, and a LV distribution board (Fig. 5.3-4) are installed.

Fig. 5.3-2 L: Pole transformer (whole), R: Operation lever of disconnecting switch

Fig. 5.3-3 Pole transformer (L: customer side, R: road side)

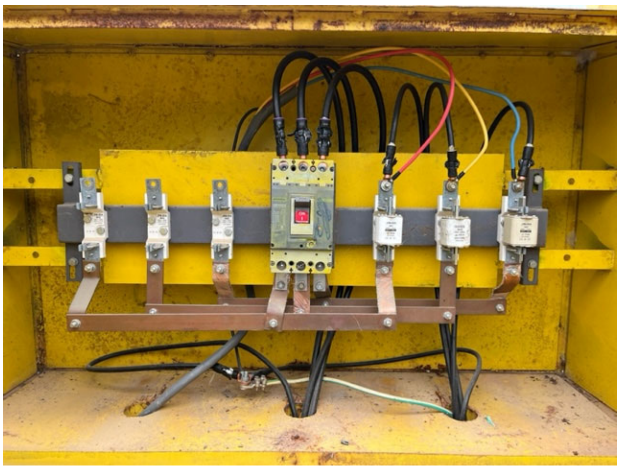
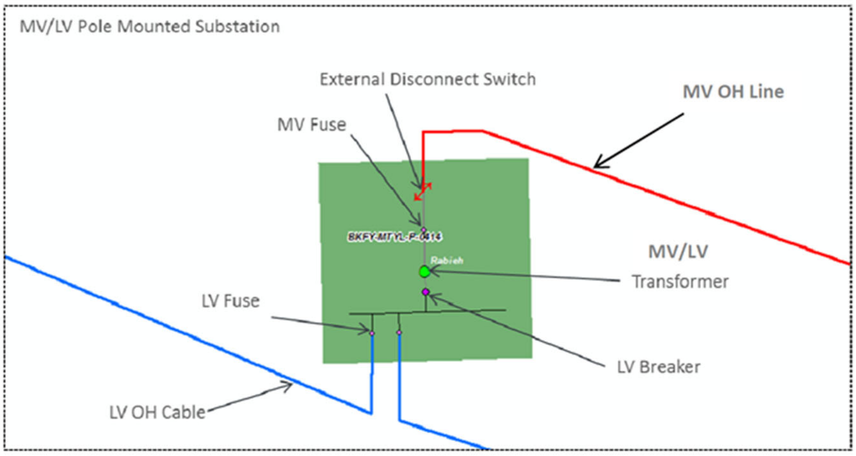


Fig. 5.3-4 Inside of the LV distribution board

Fig. 5.3-5 shows a single-line diagram of a pole transformer. The primary side of the transformer is connected to the MV distribution line through a disconnecting switch and MV fuse. On the other hand, the secondary side of the transformer is connected to the secondary bus through a LV circuit breaker. Furthermore, the secondary bus is connected to the LV cable through a LV breaker and LV fuse.

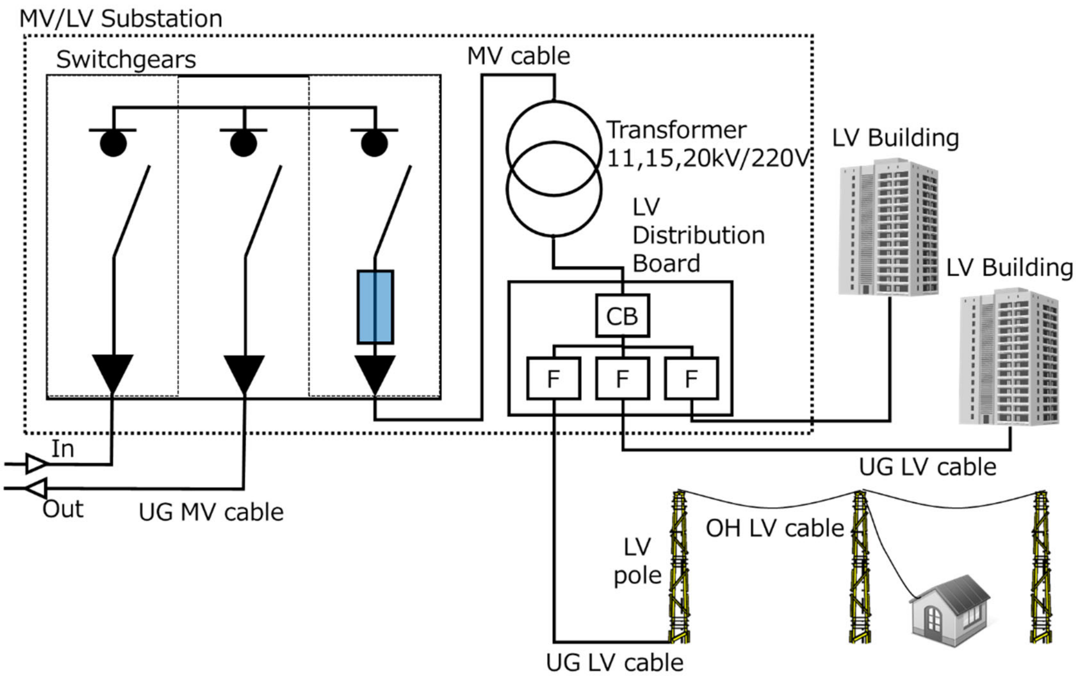


Source: EDL

Fig. 5.3-5 Single-line diagram of a pole transformer

(2) Underground areas

MV distribution facilities in Beirut city are basically underground. A typical indoor substation contains a three-phase transformer and supplies the LV power needed by nearby customers (Fig. 5.3-6).



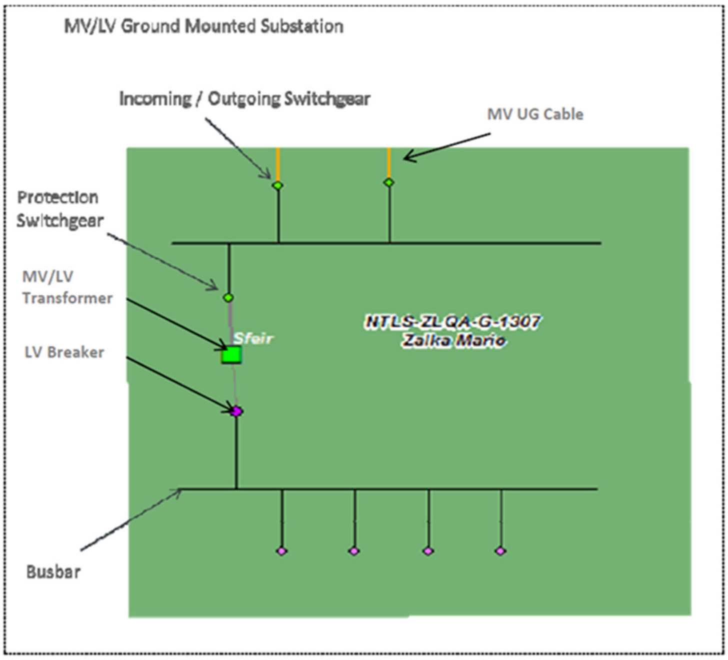
Source: JICA survey team

Fig. 5.3-6 Overview of indoor distribution substation

The space required for the installation of a substation is legislated so that EDL can be used free of charge and is installed on the premise of a general building. (Fig. 5.3-7).

Fig. 5.3-7 Entrance of indoor distribution substation

Fig. 5.3-8 shows a single-line diagram of a typical substation. Two lines are connected to the primary bus. The primary bus is connected to the transformer through a MV switch. The secondary side is connected to the secondary side bus through a breaker.



Source: EDL

Fig. 5.3-8 Single-line diagram of indoor substation

Two MV distribution lines are connected to a distribution substation by a direct burial method and are connected to MV switch. (Fig. 5.3-9: L). One line is connected to the HV/MV substation that supplies the power or to the other distribution substation on the power side. The other line is connected to the other distribution substation on the load side. Normally, the MV cable (Fig. 5.3-9: R) has three wires in a single bundle with an orange sheath. The LV cable is covered with a black sheath (Fig. 5.3-11: R).

Fig. 5.3-9 L: MV switch, R: MV cable

At the top of the transformer, there are primary terminals, secondary terminals, and various meters. MV cables are connected to the primary terminals at the back of the transformer, and LV cables are connected to the secondary terminal at the front of the transformer. The cables on the secondary side of the transformer are connected to the LV distribution board on the left side of the rack mounted on the ceiling. (Fig. 5.3-10).

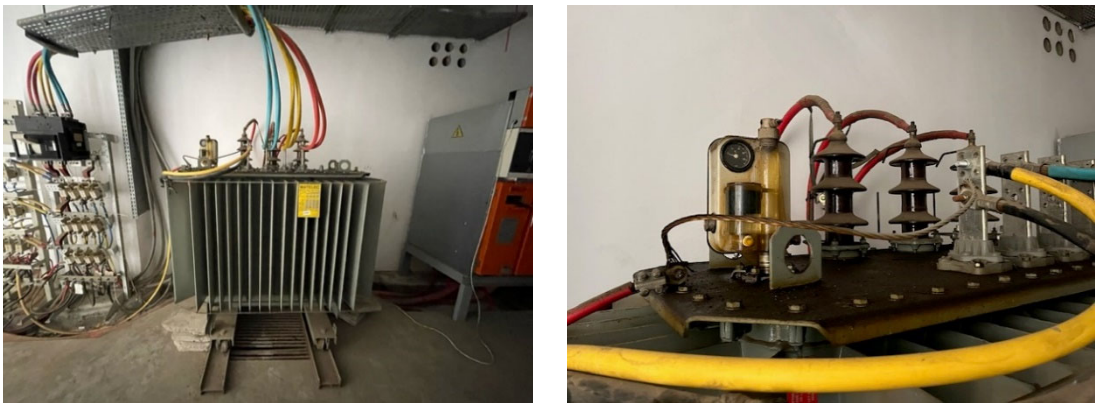


Fig. 5.3-10 Three-phase transformer (L: whole, R: upper part)

The LV distribution board contains main breakers and fuses (Fig. 5.3-11: L). The LV distribution line is connected to the LV bus through a fuse, and is buried underground directly from the distribution substation to the nearest LV pole (Fig. 5.3-11: R).

Fig. 5.3-11 L: LV distribution board, R: Incoming underground cable

Especially in areas of high demand density, multiple three-phase transformers are installed in large distribution substations (Fig. 5.3-12: L). When a MV customer exists nearby, the drop line for the customer is branched from the switch in a large substation (Fig. 5.3-12: R).


Fig. 5.3-12 L: Transformer of a large substation, R: MV switch of a large substation

When a new substation is needed due to increased demand or other reasons, but a space for the substation cannot be secured, such as in a building, a prefabricated substation is installed on the road. Compared with standard indoor substation, it has a specification of compact size (Fig. 5.3-13, Fig. 5.3-14) to save space.

Fig. 5.3-13 Prefabricated substation (whole)

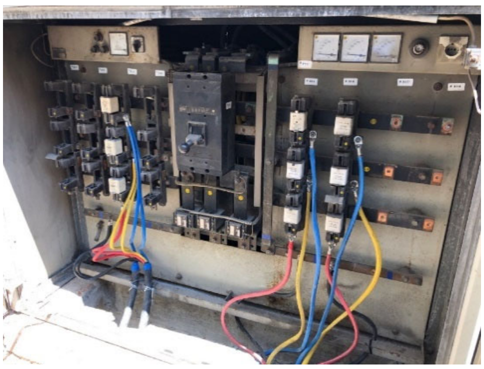
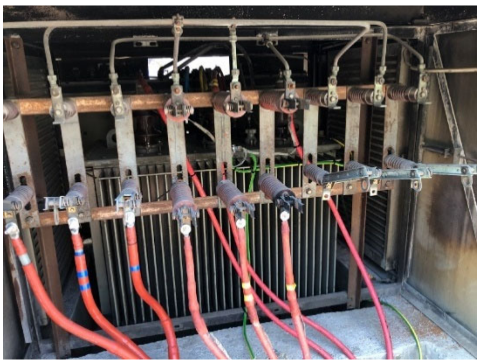



Fig. 5.3-14 Prefabricated substation (L: distribution panel, R: transformer)

(3) Statistical information

Table 5.3-7 shows statistical information on distribution transformers. In terms of the capacity of the MV/LV transformers, 250kVA accounts for 4,339 of the total 8,454 units, or about 51% of the total.

Table 5.3-7 Statistical information on distribution substations

Equipment classification		Number (units)
Distribution transformer MV/LV	25 kVA	2
	50 kVA	83
	63 kVA	18
	100 kVA	392
	150 kVA	71
	160 kVA	736
	250 kVA	4,339
	400 kVA	893
	500 kVA	610
	630 kVA	757
	800 kVA	8
	1,000 kVA	540
	1,250 kVA	2
	1,600 kVA	3

Table 5.3-8 shows a typical MV/LV transformer management list of BUS. It contains the tag name, the energization date, the primary and secondary voltage, and GIS[1] coordinate (X, Y). Although the date of creation on GIS is filled in, there are many places where the energization date is not filled in.

[1] Geographic Information System

Table 5.3-8 Excerpt from substation (MV/LV) management list for distribution substation

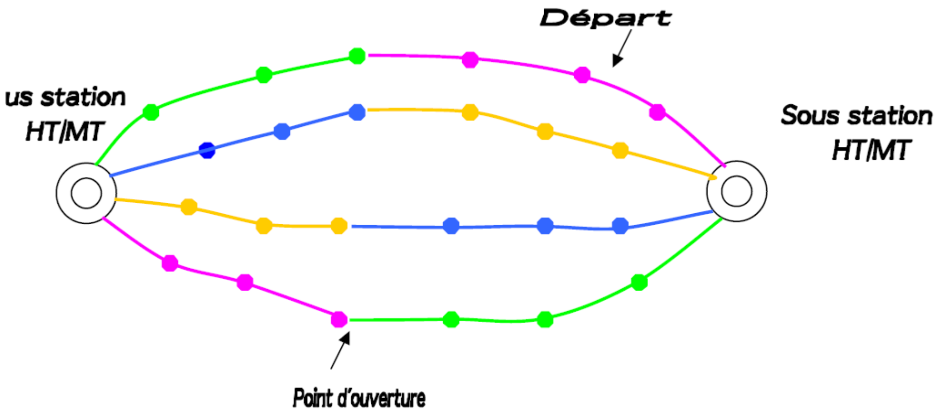
Tag Name	Common Name	Energization Date	Date of Creation on GIS	Operating Voltage	Transformer Rating (kVA)	High Side (V)	Low Side (V)	X	Y
HLBA-BSAK-P-0078			2015-07-30	15000	250	15000	380	36.19712	34.576
HLBA-ANEZ-P-0030			2015-07-30	15000	250	15000	380	36.20075	34.58598
JUNI-KFUR-P-1370			2015-07-30	15000	160	15000	380	35.69513	34.03285

5.3.5 MV Distribution Facility

(1) System configuration

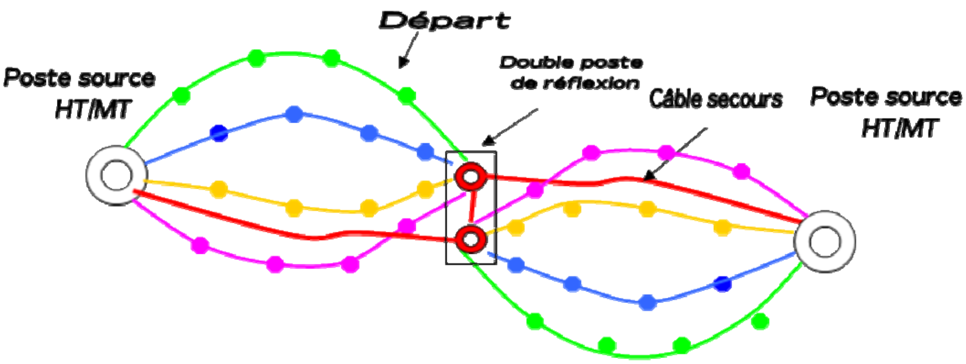
The overhead lines used outside Beirut city are radial systems with no interconnection with other distribution systems, and no automatic switch. If a fault occurs on a MV distribution line, temporally power supply to the healthy section requires manual opening of the disconnecting switch to isolate the fault point. Reverse power supply from the end of the system is not possible. Therefore, if a fault occurs on a MV distribution line, the outage continues until the fault is restored on the end side of the fault point.

On the other hand, underground facilities used inside Beirut city are being improved to have a redundant configuration that enables temporary power supply from the end side of the system in the event of an outage (Fig. 5.3-15 and Fig. 5.3-16). Therefore, the supply reliability of the MV distribution system is higher inside Beirut city than outside Beirut city.



Source: EDF Assistance technique Schémas Directeurs Electricité é Etude du Grand Beyrouth Phase 3 et 4

Fig. 5.3-15 Source-to-Source method



Source: EDF Assistance technique Schémas Directeurs Electricité é Etude du Grand Beyrouth Phase 3 et 4

Fig. 5.3-16 Spindle system

(2) Trunk line

Distribution lines are overhead outside Beirut city. Bare wires are used as conductors. In the place where LV customers exist, LV distribution lines are installed at the same pole below the MV distribution lines. Small steel towers are used as poles. There are two method to support wires: line post type and strain type. (Fig. 5.3-17, Fig. 5.3-18).


Fig. 5.3-17 L: Line post type (whole), R: Strain type (whole)

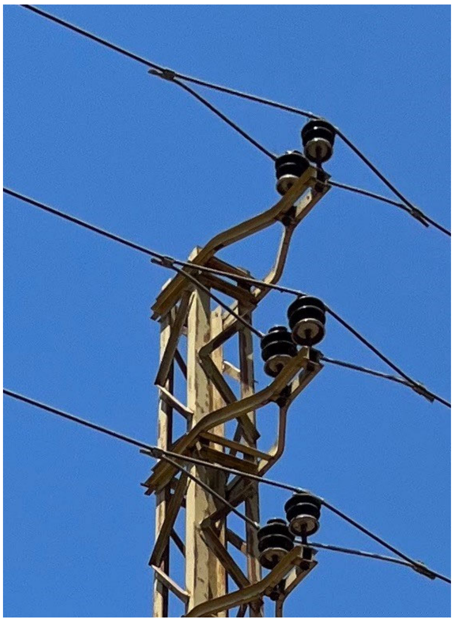



Fig. 5.3-18 L: Line post type (support position), R: Strain type (support position)

On the other hand, inside Beirut city, the MV distribution lines are underground by the direct burial method. Fig. 5.3-19 shows the state of burial of MV underground cables. Two lines enter the prefabricated distribution substation. If the underground cable needs to be rerouted and the cable length is insufficient, the cable needs to be cut and joined by digging up the underground cable in the middle of the burial route (Fig. 5.3-20: L). Epoxy resin is used for reinforcement at the cable connection points (Fig. 5.3-20: R).

Fig. 5.3-19 Buried MV Cables

Fig. 5.3-20 L: Connection of underground cable, R: Epoxy resin

(3) Disconnecting switch

The disconnecting switches are installed on overhead MV distribution line (Fig. 5.3-21). The outage section can be limited by manually opening the disconnecting switch.

Fig. 5.3-21 Disconnecting switch of MV distribution line

5.3.6 LV Distribution Facility

(1) Trunk line

LV distribution lines in Lebanon are almost overhead lines, and if there are MV distribution lines, they are installed below them near the center of a pole. Insulated or bare wires are used for the wires Fig. 5.3-22). In the past, bare wires were used, but they are gradually replaced with insulated wires, which are more difficult to theft power. Although the electrical circuit is a 3-phase, 4-wire system, a cable for the voltage phase dedicated to street lighting is added, so the insulated wire is 3-phase, 5-wire. (Fig. 5.3-23).

Fig. 5.3-22 LV trunk line (L: insulated wire, R: bare wire)

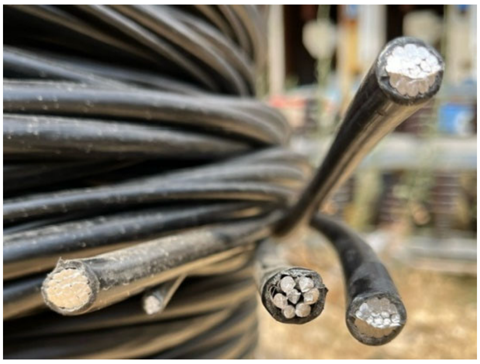


Fig. 5.3-23 LV insulated wire

(2) Drop line

Many customers have two drop lines, one from EDL and the other from a Private Generator. The drop line at the top of the pole is EDL's and below it is Private Generator's (Fig. 5.3-24).

Fig. 5.3-24 LV drop line

5.3.7 Meter

EDL uses single-phase, 2-wire mechanical meter to customers with contracted capacities up to 60 A, and 3-phase, 4-wire mechanical meter to customers with contracted capacities of 60A or more. (Fig. 5.3-25).

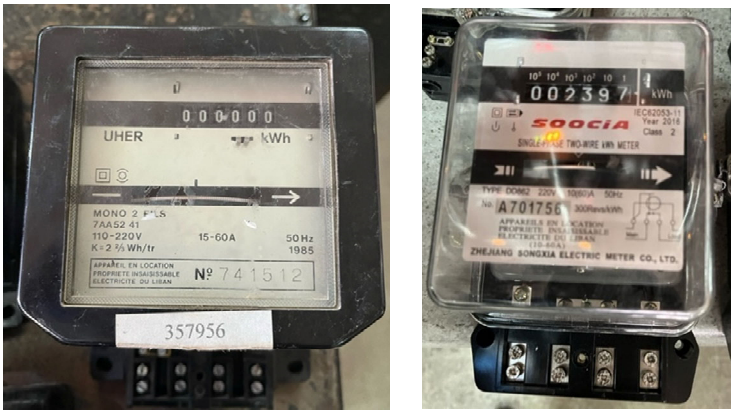


Fig. 5.3-25 Mechanical meter

In Lebanon, there is no legal requirement for the usage period or certification period of a meter, but the manufacturer recommends a life cycle of about 20 years. The main cause of life cycle is due to increased resistance of the rotating parts of the mechanical meter due to wear of the bearings. Fig. 5.3-26). However, the actual amount of rotation of the meter is low, because the current power supply from the EDL is only available for a maximum of four hours per day, which allows the meter to be used for a longer period of time. Under the AMI project, EDL promotes the installation of smart meters, but still installs mechanical meter to new customers, given the lack of funds for the purchase of smart meters.

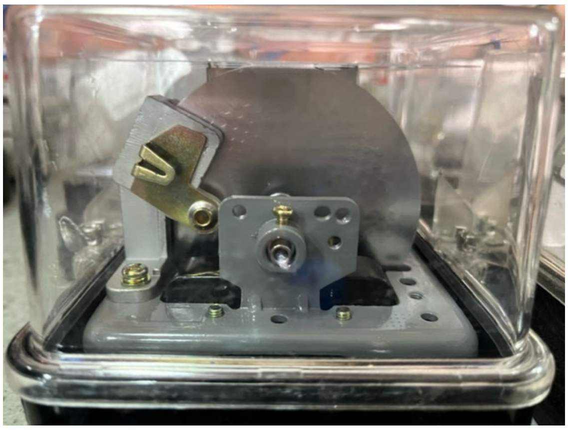


Fig. 5.3-26 Bearing parts of mechanical meter

On the first floor of the EDL headquarters building, there is a meter test room. (Fig. 5.3-27: L). Mechanical meters removed after the use are collected in the test room. The collected mechanical meters are checked for accuracy of metering errors and reused after necessary repairs (Fig. 5.3-27: R).

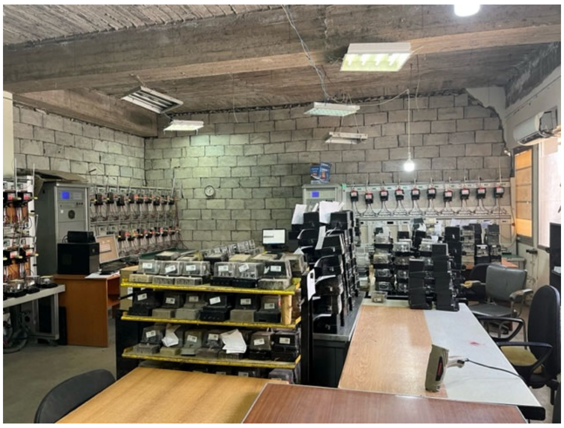
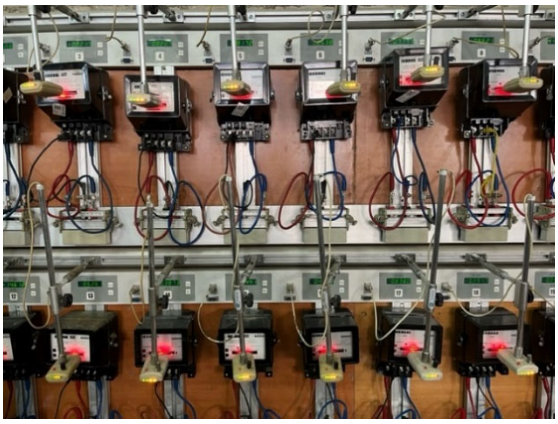



Fig. 5.3-27 L: Meter test room, R: Accuracy test for removed meters

5.4 INFORMATION ABOUT DISTRIBUTION FACILITIES UNDER CONSTRUCTION AND PLANNING

The 2015-2030 Distribution Master Plan was developed by EDF in 2016 as an investment plan mainly for the capital BAYROUTH region, due to the aging distribution facilities and increasing demand in Lebanon. This master plan was reviewed with the aim of achieving the following five objectives for DSP's business.

- Comply with technical constraints (strength constraints, voltage drop)
- Secure stable supply (considering power loss of supply side substations)
- N-1 criterion (continue to be supplied in the event of a single line fault)
- Secure service quality (reduce the number and duration of outages)
- Optimize technical loss in consideration of economic efficiency

The investment plan under the above five items has the following four main features.

- Emergency plan for eliminating overload
- Development of distribution systems to support urban expansion
- Reinforcement of MV systems by installing switches, etc.
- Boosting voltage from 11kV and 15kV to 20kV

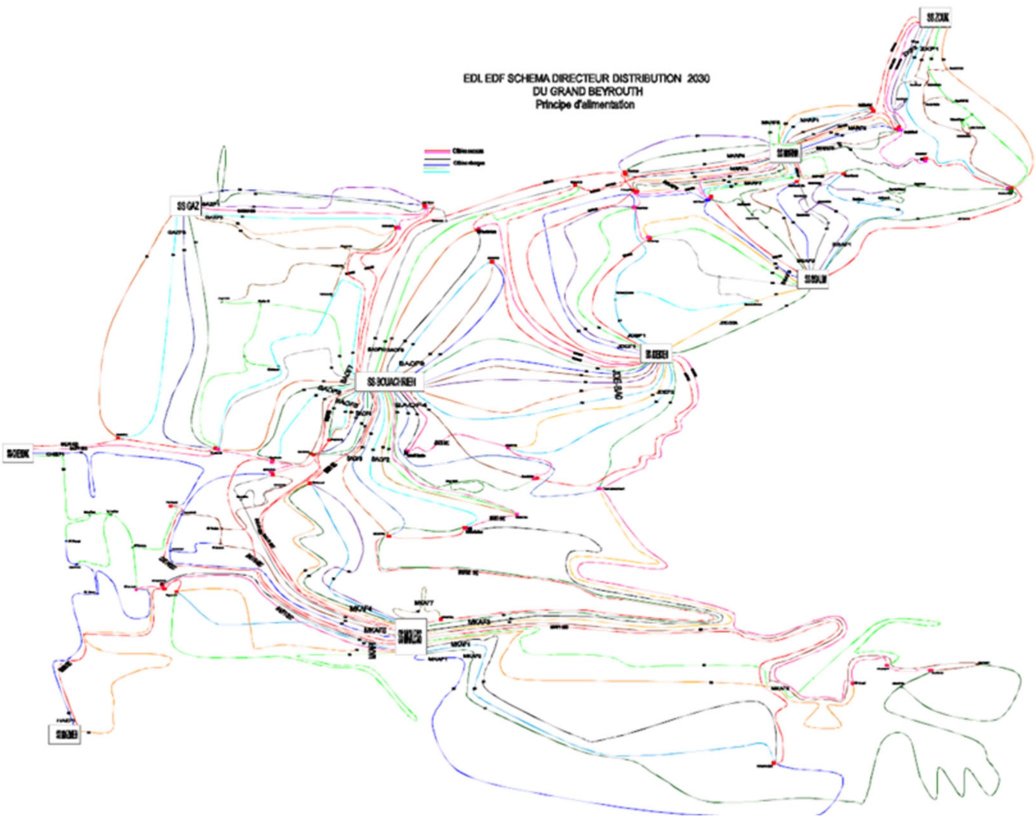
This master plan describes the plans of investing in distribution facilities in ANTELIAS region, BAYROUTH region, and CHIAH region, which are divided into three areas. The outline of investment plans for each area is shown in the following sections. However, due to the lack of EDL funding, most of the investment plans are stagnant.

5.4.1 Outline of Investment Planning in ANTELIAS Region

The following are the two main investment plans for ANTELIAS region until 2030 (Fig. 5.4-1).

1. Renovation and reinforcement of existing cables of 477km
2. Installation of 240 Aluminum Cables of 256km to boost the voltage from 11kV and 15kV to 20kV

These total investments are expected to be approximately $24.4 million.



Source: EDF Assistance technique Schémas Directeurs Electricité é Etude du Grand Beyrouth Phase 3 et 4

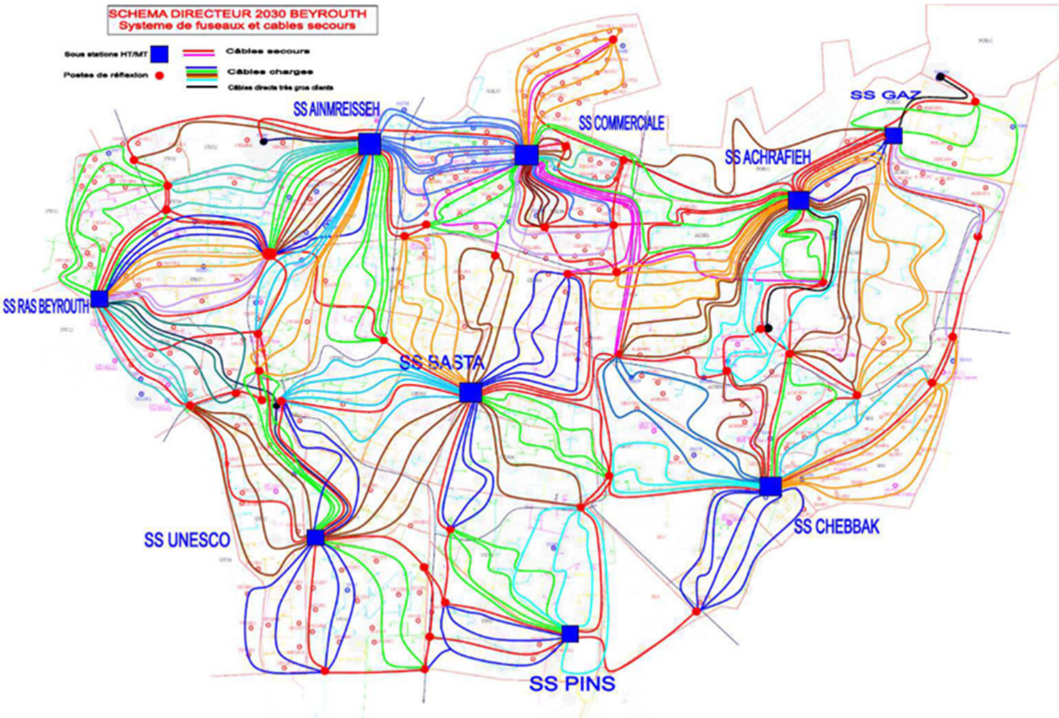
Fig. 5.4-1 ANTELIAS region distribution system plan (2030)

5.4.2 Outline of Investment Plan in BAYROUTH Region

The following are the two main investment plans for BAYROUTH region until 2030 (Fig. 5.4-2)

1. Renovation and reinforcement of existing cables of 370km
2. Installation of 200km Cables to boost the voltage from 11kV to 20kV

These total investments are expected to be approximately $18 million.



Source: EDF Assistance technique Schémas Directeurs Electricité é Etude du Grand Beyrouth Phase 3 et 4

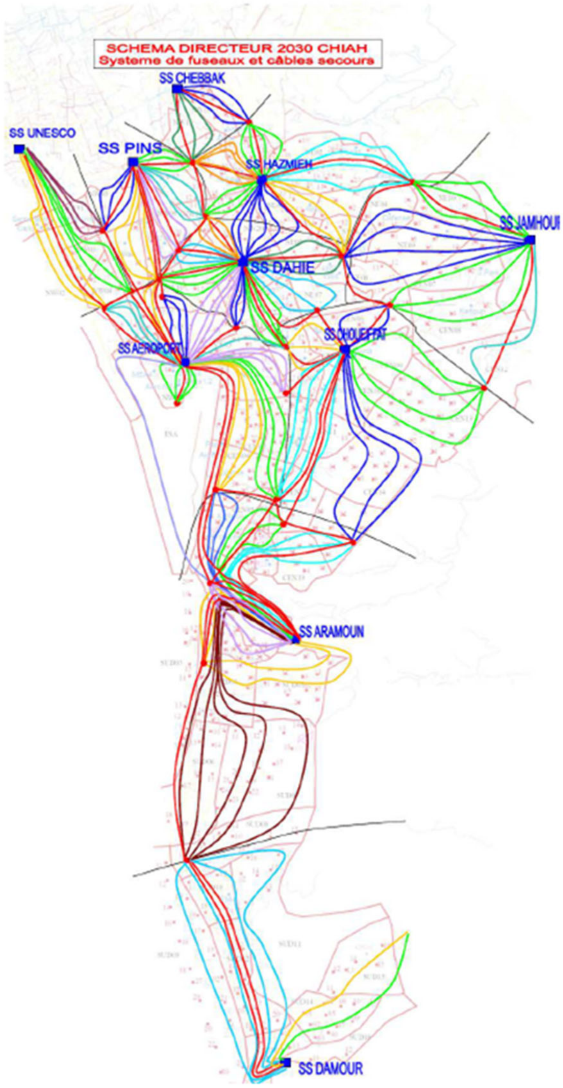
Fig. 5.4-2 BAYROUTH region distribution system plan (2030)

5.4.3 Outline of Investment Plan in CHIAH Region

The following are the two main investment plans for CHIAH region until 2030 (Fig. 5.4-3).

1. Renovation and reinforcement of existing cables of 650km
2. Installation of 300km cables to boost the voltage from 11kV and 15kV to 20kV

These total investments are expected to be approximately $27 million.



Source: EDF Assistance technique Schémas Directeurs Electricité é Etude du Grand Beyrouth Phase 3 et 4

Fig. 5.4-3 CHIAH region distribution system plan (2030)

5.5 INFORMATION ABOUT COLLECTION OF ELECTRICITY TARIFF FROM CONSUMERS

5.5.1 General Overview about the Collection of Electricity Tariff

The collection of electricity tariffs are broadly classified into meter reading, calculation, billing, and collection. EDL is responsible for calculation and billing, and DSPs for meter reading and collection based on the billings (Table 5.5-1).

Table 5.5-1 Flow of electricity tariff collection

Operation	Subject	Step	Work
Meter reading	DSP	1	Go to customers' premises, read meter indexes
		2	Go back to office, record meter indexes on the DSP's database
		3	Submit the compiled meter indexes to EDL by e-mail
Calcula-tion	EDL	4	Store the received meter indexes in data server of EDL
		5	Check the received meter indexes if there are any suspicions
		6	Calculate the tariffs from the meter indexes
Billing		7	Download the data and print out bill papers
Tariff collection	DSP	8	Go to EDL's office and receive the bill papers
		9	Go to customers at least twice for one bill and collect tariffs
		10	Deposit collected tariffs into EDL's bank account
Supply stop	EDL	11	Decide to stop the power supply to the outstanding customers
	DSP	12	Stop the power supply to the customers designated by EDL

The expanding installation of smart meters under the AMI program is expected to improve meter reading, billing, and supply stopping operations by enabling remote meter reading and remote disconnection. On the other hand, the continued non-payment of tariffs by public institutions and power theft in refugee camps are major factors in EDL's financial deterioration. The Lebanese government has proposed a measure to address the non-payment of electricity tariffs by public institutions by allocating a portion of the public institution's budget to electricity tariffs, but the status of this measure is not yet clear. Campaigns for the removal of illegal connections are underway to solve the power theft in refugee camps.

5.5.2 Calculation and Billing

EDL stores the results of meter reading in the company's data servers. The data servers are redundant and exists in two places. The master server is located in Zouk power plant and the slave server is located on the first floor of the EDL headquarters (Fig. 5.5-1: L). Prior to the explosion at Beirut port, the server on the third floor of EDL headquarters was the master and the server at Zouk plant was the slave. When the Beirut port exploded, the old master server on the third floor of the headquarters was destroyed, so the slave server in Zouk power plant was changed to the master server. The slave server currently installed on the first floor of EDL headquarters was installed by diverting reusable components from the old master server on the third floor (Fig. 5.5-1: R). The current slave server is installed in a temperature-controlled space, but the power supply is not doubled, and the necessary stability is not ensured. In addition, optical fibers were previously used as communication lines in the headquarters building, but LAN cables are currently used.

Fig. 5.5-1 Data Server (L: New, R: Old)

Next, the EDL staff checks the meter indexes. If there is no suspicion in the meter indexes, the electricity tariffs are calculated. The EDL staff downloads the calculated electricity tariffs to PC connected to the printer for printing the bills and prints the bills. The original paper of the bill is printed with a predetermined layout, and the printer prints only the data of each customer. The printer for LV customers is transferred to the first floor, and the printer for MV customers is installed in the third floor since before the explosion at the port of Lebanon (Fig. 5.5-2). Three LV customers' bills can be printed at once and it is easy to separate by hand along the perforations.

Fig. 5.5-2 Bill printer (L: New, R: Old)

5.5.3 Collection

Tariffs of end consumers are collected either in cash or by checks or by bank account transfers. In the BUS area, it has almost been replaced by bank transfers, and the average collection rate of electricity tariffs until 2019 is about 95%. When receiving payments directly from customers in cash or other forms of payment, the DSP dispatches collectors to collect the tariffs.(Fig. 5.5-3). Depending on whether the customer is home or not, a second visit is sometimes made, in which case the action taken is different from the first visit. Table 5.5-2 shows the difference in the action between the first visit and the second visit by the collector.

Source: BUS website

Fig. 5.5-3 L: Meter reader and collector Certificate, R: Warning notification example

Table 5.5-2 Comparison of actions at first and second visits by collectors

Visit	Action
First time	- The collector leaves a notification describing the tariff and due date of the bill and the schedule for the second visit (usually within 3 days).
Second time	- If the customer is absent, the collector leaves a warning notification. - The customer contacts the DSP with the contact information stated in the notification and determine the date of collection. Or the customer go to the nearest DSP office for payment. - If the customer does not pay by the due date, the DSP stops power supply based on the judgment of EDL

CHAPTER 6

IMPLEMENTATION STRUCTURE PLAN OF INTEGRATED ELECTRICITY MASTER PLAN

CHAPTER 6 IMPLEMENTATION STRUCTURE PLAN OF INTEGRATED ELECTRICITY MASTER PLAN

6.1 REVIEW OF FORMULATION AND IMPLEMENTATION STRUCTURES FOR DEVELOPMENT PLANNING IN THE POWER SECTOR

In this section, JICA Study Team review the current situation of capacity of MoEW and EDL for the formulation and implementation of development planning in the power sector. In capacity development for planning, the focus is often on the improvement of personal skills of engineers in charge. However it is difficult to deal with the unexpected reassignment or retirement of personnel if these individuals are only subject to the capacity development. In other words, there are challenges in technology transfer among concerned organizations. In order to strengthen the specific institutional structure for effectively performing the planning functions required for formulation, implementation and periodical update development plan, it is important to improve the comprehensive system surrounding structures of formulation, recognizing not only the individual, but also the organization and the external environment such as laws and regulations as one interactive system as shown in Fig. 6.1-1.

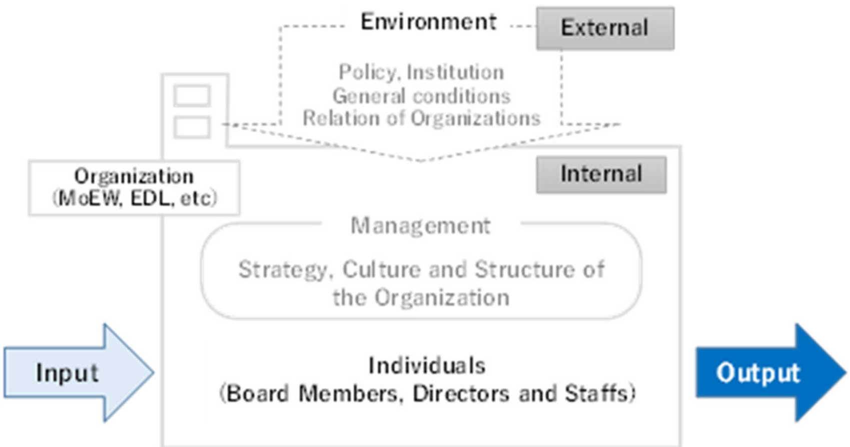


Fig. 6.1-1 Target of Capacity Development in Technical Cooperation

6.1.1 Legal System and Implementation System for Development Planning

(1) Legal System for Development Planning

Table 2.3-1 summarizes the main legal systems in Lebanon's power sector. The law related to the so-called power law is "Regulation of the Electricity Sector" issued in 2002.

In this law, Article 6 stipulates policy and development plan formulation as MoEW's jurisdiction and Article 12 describes development plan formulation and approval by CoM for transmission and distribution.

(2) Implementation Structures and Roles for Development Planning

1) MoEW

Current situation of the implementation structures and capacity of development planning at MoEW is summarized based on materials related to organizational structures and the results of a hearing with several stakeholders.

The business in the power sector is under the jurisdiction of the General Directorate of Exploitation which consists of a total of 11 departments in MoEW. According to the hearing, the number of staff in this department is 48 including general affairs and there are four engineers in charge of technical matters: two in electrical and two in water resources. The organizational chart based on these is shown in Fig. 6.1-2.

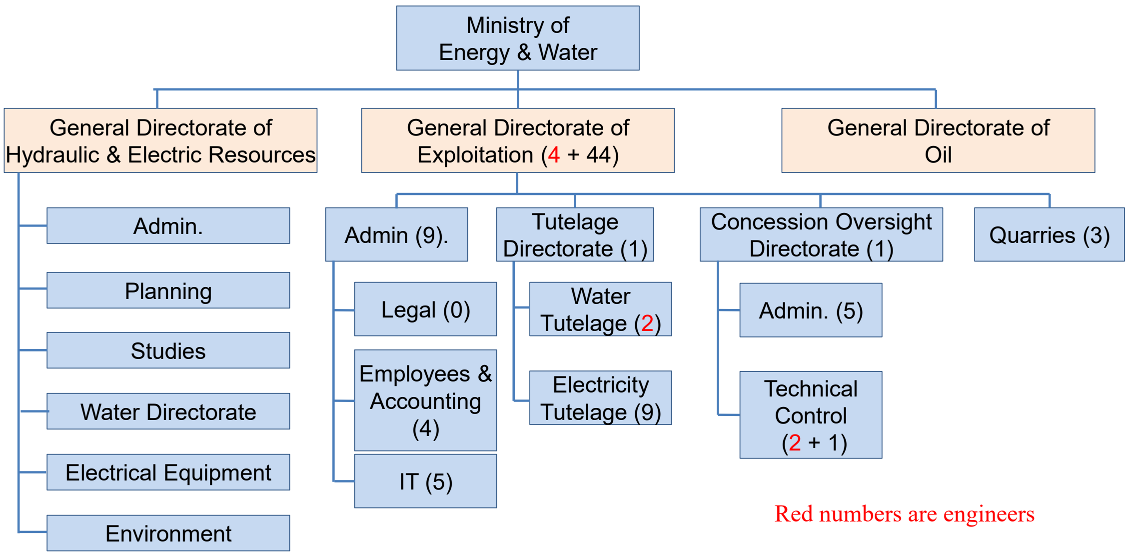


Fig. 6.1-2 Organization Chart of MoEW with numbers of Staffs

MoEW's power policy includes Policy Paper in 2011, Updated Policy Paper in 2019 and Setting Lebanon's Electricity Sector on a Sustainable Growth Path in 2022. As for development plans, there are Update of Transmission Master Plan in 2017 and Least Cost Generation Plan in 2021. EDF had been in charge of technical studies and other work as an external consultant.

2) EDL

Regarding the implementation structures and capacity for development planning at EDL, interviews with Heads of Distribution Department, Study Department, Transmission Department and Generation Department had been carried out and their involvement in each development plan and their planning capacity had been confirmed. Fig. 6.1-3 shows EDL's organizational chart. In addition, several suggestions on EDL's current situation and capacity had been obtained from various stakeholders including MoEW and development partners through the discussion with them. The results of these hearings are summarized below.

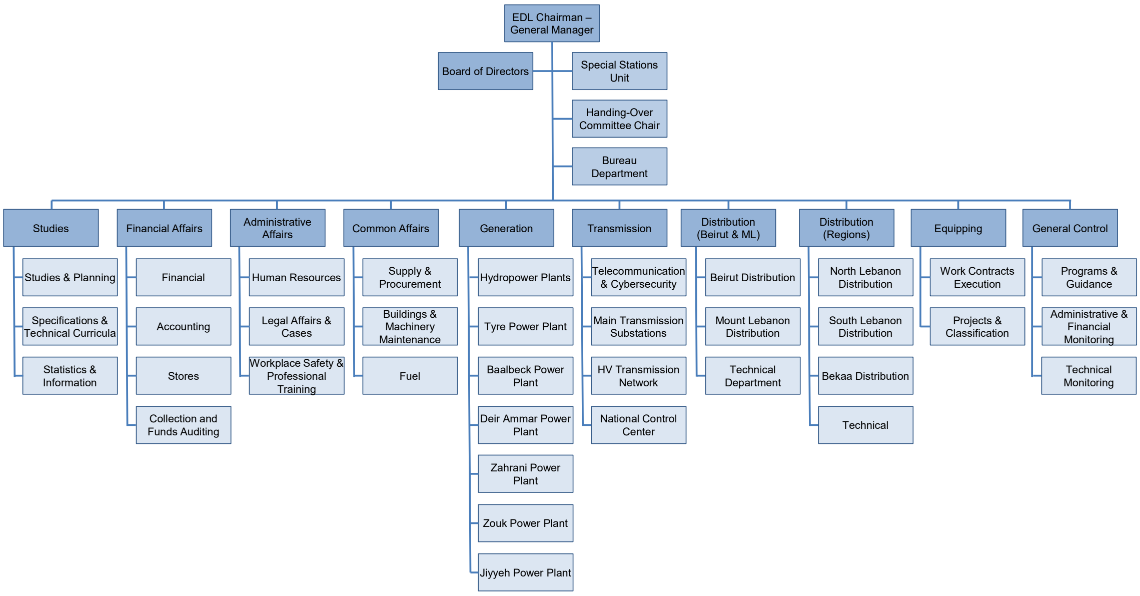


Fig. 6.1-3 Organization Chart of EDL

EDL has Study and Planning Department under the Study Directorate which consists of Exploitation Division that arranges land acquisition for new power plants and substations and Planning Division that formulates development plans. The Study and Planning Department has three engineers including Head of Department. Although they are responsible for the formulation of development plan as an organizational role, it is expected that it is difficult to cope with it alone from the current personnel structure, technical ability and experience.

Regarding planning capacity, EDL has been involved in development plans such as Distribution Master Plan in 2015, Update of Transmission Master Plan in 2017 and Least Cost Generation Plan in 2021. When EDL worked on these projects, they establish a committee consisting of capable staffs from related departments selected by EDL's management. Each Committee is headed by a department of each responsible field. It is also noted that it is difficult to be in charge by only one department due to the serious scarce of human resources and is required to assign staffs from several departments.

For examples of the existing projects, Study Department was the main body for the Distribution Master Plan in 2015, the Transmission Department was for the Update of Transmission Master Plan in 2017, and the Generation Department was for the Least Cost Generation Plan in 2021.

It is also confirmed that the consultants such as EDF had conducted formulation of these plans itself. In interviews with Heads of each department, EDL could not be actively involved in technical studies for plan formulation and it is hard to say that knowledge or experience of plan formulation has been accumulated in EDL. As for planning tools, EDF had owned PRAO, distribution planning in the past but they are not renewing maintenance contracts now. As of 2023, they do not have tools necessary for analysis of development plans such as WASP or PSSE.

6.1.2 Review of Formulation and Implementation Structure

In considering the capacity on the formulation and implementation structure of development planning, the current situation is organized by focusing on the organizational structure and capacity of MoEW and EDL. As a result, it is confirmed that the Lebanese power sector has been facing many difficulties since 2019 and it is necessary to consider the following three external environments surrounding the sector.

i. The impact of the financial crisis since 2019
ii. The depreciation of the Lebanese currency
iii. The impact of the Beirut port explosion in 2020

These issues are not caused by MoEW and EDL and Lebanese government should address to them. However, their impacts are seriously affected to the formulation and implementation of development plan. Fig. 6.1-4 and Table 6.1-1 summarizes the recognition of these issues and practical situation.

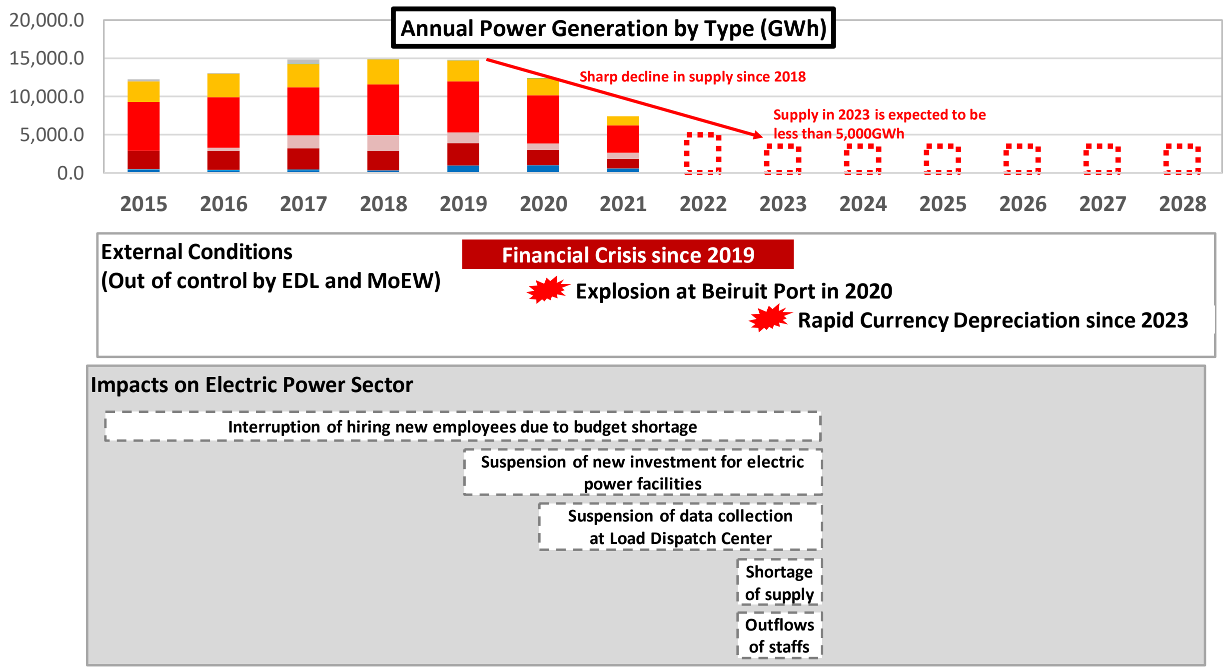


Fig. 6.1-4 Surrounding External Conditions and Impacts on Electricity Sector

Table 6.1-1 Understandings of Issues on Formulation and Implementation of Development Plan

<table>
<tr><th>Item</th><th>MoEW</th><th>EDL</th></tr>
<tr><td>External Environment</td><td colspan="2">- The salaries in LBP are affected by inflation and exchange rate fluctuations.
- The ongoing projects are suspended and new projects are halted due to the financial crisis. Organization - There is a serious shortage of staff engineers in the power sector.</td></tr>
<tr><td>Organization</td><td>- Many staff members do not come to work due to strikes.
- The hiring of new staff is suspended.
- The development plan is handled by the Advisor and the knowledge is not accumulated in the organization.</td><td>- There is a common shortage of personnel in each department, and there are no young engineers.
- The hiring of new staff is suspended.
- The development plan is mainly formulated by external consultants and the knowledge is not accumulated in the organization.
- The management of system operation information, etc. has not been done since 2019.</td></tr>
<tr><td>Personnel</td><td colspan="2">- They do not own planning tools. Individual ability - There are no staff members who can use planning tools such as PSSE.
- They have no experience in preparing medium- and long-term electricity demand forecasts.
- They have no experience in analyzing power generation development plans.
- They have no experience in preparing transmission system development plans.</td></tr>
</table>

It is confirmed that particularly the shortage of staffs at MoEW and EDL is serious as a direct impact but it is expected that the situation will not improve until the problems caused by the external environment are solved. In other words, it is difficult for MoEW and EDL to remove the inhibiting factors for strengthening the development planning and implementation system by their own efforts alone.

On the other hand, EDL has a high awareness of the problem of capacity improvement for development plan formulation and has a strong desire to improve analysis capacity using planning tools. Although it is a very difficult situation, they answered that it is possible to secure staff necessary for technology transfer.

6.2 RECOMMENDATIONS FOR ENHANCEMENT OF CAPABILITIES FORMULATING THE DEVELOPMENT PLANS IN ELECTRICITY SECTOR

Based on the reviews in the previous section, recommendations for enhancement of capabilities formulating the development plans in electricity sector are described below:

- Target periods of the development plan shall focus on the short – medium term which aims to improve the gap between demand and supply and has higher priority rather than medium – long term.
- Emphasis shall be placed on data collection, which has not been systematically carried out since the financial crisis from 2019 and the Beirut port explosion in 2020, in order to rebuild the fundamental information for EDL's technical studies.
- Considering the shortage of human resources in EDL and MoEW, the use of external resources such as hiring consultants shall be incorporated for capacity enhancement. However, it should be noted that it is important to emphasize technology transfer to EDL and MoEW in these tasks.
- Introduction of analysis tools necessary for formulating generation and power system planning.

Based on the recognitions above, considerations for formulating short to medium-term implementation plans under the current situation are shown in Fig. 6.2-1.

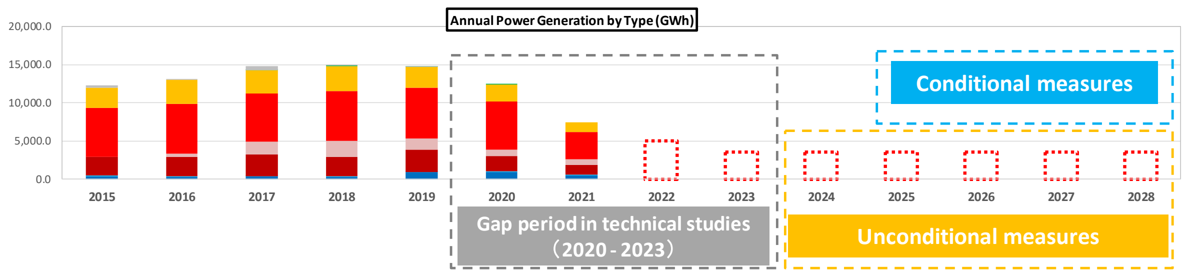


Fig. 6.2-1 Considerations on Short to Medium Term Implementation Plans

Since the Beirut port explosion in 2020, EDL has been unable to conduct data collection through the load dispatching center and technical studies due to a lack of facilities and personnel. As a result, there has been a gap since 2020 and the actual power demand has not been understood during this period. Thus it is essential to carry out a baseline survey to fill this gap as preparatory works for planning. Particularly, although amount of data for power demand is vast, it is a fundamental information for the short to medium term implementation plan focusing on the operation of demand and supply to improve the dependency on diesel generators in each district or to prepare the load dispatch plan based on load of each substation

Based on this data collection, the demand and supply model is established involving distributed renewable energy, operation of existing thermal power plants based on the revenue and expenditure situation with the new tariff structure and strategic load allocation with priority. Through these studies, challenges in the short to medium term are clarified.

As for the direction of development such as generation mix and network configuration in the medium to long term, the basic concepts had been already studied in existing development plans as shown in Chapter 3 and these are still expected to be effective. On the other hand, many of the projects assumed in these development plans have been suspended. These projects are supposed to be not in progress due to external conditions that EDL and MoEW can't handle by themselves (Conditional). Therefore, in the short term, projects that EDL and MoEW can implement on their own (Unconditional) are studied as a base scenario for short to medium-term implementation plans. Based on this, multiple scenarios combining Conditional projects are considered to clarify the projects and measures that should be prioritized.

The implementation plan formulated indicates the blueprint of next steps for the electricity sector. As of October 2023, there is no prospect of resolving the financial crisis and currency depreciation. However, if these constraints are resolved and support from various countries and development partners resumes, it will be possible to indicate which measures the sector should focus on. Cross-sectoral integrated insights, including demand, generation, power system and finance, are required for this consideration but it is essential for Lebanon to rebuild the power sector. Improving planning capabilities is expected to be an important issue.

CHAPTER 7

RECOMMENDATIONS ON THE FUTURE TECHNICAL COOPERATION

CHAPTER 7 RECOMMENDATIONS ON THE FUTURE TECHNICAL COOPERATION

In this chapter, recommendations on the future technical cooperation by Japan is considered based on the results of data collection in this study and the understandings shown in Chapter 6.

7.1 BACKGROUND OF THE TECHNICAL COOPERATION

Lebanon's Électricité du Liban (EDL), a vertically integrated public utility with exclusivity over electricity generation, transmission and distribution in the country, has been unable to meet prevailing demand in the country for decades. The Lebanese government has tackled strengthening the power sector with annual budget support, but it was mainly focused on fuel and operational expenditures remedying the generation capacity gap.

Currently, Lebanon is under an economic and financial crisis which is compounding the power sector's historical challenges. Although EDL has installed a generation capacity of around 2,300 MW excluding hydropower plants, the utility's ability to meet electricity demand, which was already limited before the crisis, has further deteriorated because of a lack of imported fuel supply. In response to such a crisis, the Ministry of Electricity and Water (MoEW) finalized its comprehensive 5-years plan (2022-2026) "Setting Lebanon's Electricity Sector on a Sustainable Growth Path", following "Update of the Transmission Master Plan of Lebanon" by Électricité de France (EDF) in 2017, "Emergency Action Plan" by World Bank in 2020, and "Least Cost Generation Plan" by EDF in 2021.

EDL have been facing severe challenges such as financial crisis, explosion of Beirut port and currency depreciation. These issues are due to external circumstances beyond the control of EDL and are issues which Government of Lebanese needs to deal with. On the other hand, the impacts on EDL is significant, facing difficulties such as interruption of new employees, suspension of new investment for generation and transmission facilities and disruption of data management due to the damages at the load dispatch center. Base on the understandings above, strengthening the financial and institutional capacity of EDL is essential to reconstruct the business of electricity sector and realize the formulated development plans in the future.

In addition, as described in Section 4.2.3, Power Flow of Bulk Power System, another issue is the difficulty of grasp actual demand. Those are due to 1) changes in daily load patterns and increases in potential demand resulting from the installation of a huge number of loop-top solar generation systems at each customer as a result of years of continuous power outages, and 2) unknown regional load volumes and total load for the entire country due to damage to the Load Dispatch Center, making it difficult to determine the current status of actual demand. Therefore, in the future technical cooperation, it is necessary to find ways to efficiently assess the current status of supply and demand with the limited resources of the EDL. In particular, since the financial crisis, demand has decreased significantly due to the shortage of fuel for thermal power plants. For example, with respect to the total demand for the entire country, it is necessary to make demand assumptions for a case in which the effects of the economic collapse, the effects of a large increase in electricity prices, and the massive deployment of renewable energy are factored into the load state before the economic collapse, and to proceed in consultation with EDL to ensure an efficient and smooth transition to optimal grid operation. In addition, it is necessary to proceed with a smooth transition from the current recovery to stable and economic planning and operation in the future, taking into account the operation of large thermal power sources (e.g., CCGT thermal power generation in the northern part) to meet future demand increases that may occur after the financial crisis. Here, we believe that the transfer of simulation technology based on demand assumptions and power supply composition will contribute to the improvement of autonomous planning and operation capabilities to specifically formulate optimal grid planning and operation.

7.2 PROPOSED FRAMEWORK FOR THE TECHNICAL COOPERATION

Proposed framework for the technical cooperation by JICA Study Team is shown in Table 7.2-1.

Table 7.2-1 Proposed Framework for the Technical Cooperation

Item	Contents
Project Title	Project for Formulation of Blueprint for EDL Reconstruction
Project Outline	
(1) Overall Goals	To reconstruct financial and institutional capacity of EDL based on formulated blueprint.
(2) Outputs	To formulate Blueprint for EDL Reconstruction in coordination with key stakeholders.
(3) Activities	The Project will carry out the following tasks in collaboration between EDL staffs and JICA Experts. Task 1 Review of the current situation on electricity sector and preparation of the baseline survey for Blueprint for EDL Reconstruction Task 2 Formulation of institutional capacity strengthening plan of power demand forecast Task 3 Enhancement of the introduction of distributed renewable energy Task 4 Economic and financial analysis of EDL Task 5 Formulation of the institutional arrangement plan Task 6 Formulation the Blueprint for EDL Reconstruction
Counterparts	Implementing Agency :EDL (Électricité du Liban) Supervising Agency :MoEW (Ministry of Electricity and Water)
Project Period	18 months

APPENDICES

APPENDIX-1

LIST OF PARTIES

LIST OF PARTIES

No	Organization	Department	Position	Name
1	MoEW		Minister	Walid Fayad
2	MoEW		Senior Advisor	Khaled Nakhle
3	MoEW		ex Director General of General Directorate of Oil	Aurene Fephely
4	MoEW	Technical Department		Ahmed Moussaowi
5	MoEW		Electrical Engineer	Lamia Hamad
6	EDL	General Director	Chairman of Board	Kamal F. Hayek,
7	EDL	Regional Distribution	Head of Technical Department	Jihad Ghadieh
8	EDL	GEX Directorate	Head of GEX Directorate	Beshou Aliel
9	EDL	Regional Distribution	Head of Regional Distribution Directorate	Ghassam Darwich
10	EDL	Study Department	Net Metering Committee and Head of Study Department	Rima Assaf
11	EDL	Eclectic Department	Head of Electric	Nabim elabus
12	EDL	Transmission Network Department	Head of Transmission Network Department	Ramzi El Dobeissy
13	EDL	Beirut Department and AMI	Head of Beirut Department and AMI	Tarek Mausow
14	EDL	Study Department	Head of Study Department, Study Directorate	Raja El-Ali
15	EDL	Hydropower Plants Department	Head of Hydropower Plants Department	Faoli Bon Khsam
16	EDL	Distribution (Beirut and ML)	Head of Distribution (Beirut and ML) Directorate	Ibrahim Moussa
17	EDL	Studies and Planning Department	Head of Studies and Planning Department	Ghada Charfouni
18	EDL	Statistics and Information Department	Head of Statistics and Information Department	Gladys Daru
19	EDL	Transmission Directorate	Transmission Director	Rabih Daou
20	EBRD			Merhi, Firas
21	LRA	Hydropower Department		Ghassam Gesran
22	LRA	Governance Department	Head of Governance Department	Nassim Asou Hamad
23	LRA		General Director and Head of Board	Sami Alawieh
24	LCEC:Lebanese Center for Energy Conservation		President of the board	Pierre El Khoury
25	Word Bank	Leader for Infrastructure	Senior Energy Specialist	Alexis Made lain
26	USAID		Senior Local Development Specialist	Sana Saliba Khoury
27	USAID		Program Management Specialist	Rana Helou
28	UNDP	Energy & Environment	Programme Manager	Jihan Seoud
29	JICA Lebanon			Zeina Khalaf Helou

No	Organization	Department	Position	Name
30	JICA Jordan Office		Chief Representative	Junji WAKUI
31	Embassy of Japan in Lebanon		Ambassador Extraordinary and Plenipotentiary	MAGOSHI Masayuki
32	Embassy of Japan in Lebanon		First Secretary	YAMAGUCHI Maki
33	EBML		Technical Director	Ghada Rida
34	EBML			Tony Zoghby
35	EDL	La Kadischa		Abdel Rahman Mawas
36	EDL	La Kadischa		Bassem Khayat
37	NLWE (North Lebanon Water establishment.)		Director General	Khaled Obied.
38	NLWE (North Lebanon Water establishment.)		Technical/Investment Director	Gaby Nasr
39	EDL	Distribution Directorate	Regional Distribution Directorate	Gibran Magraani
40	KVA (DSP)		Project Manager for DSP project	Mohammad Katerji
41	KVA (DSP)		Construction Engineer	Bilal Shaaban
42	MRAD (DSP)		Project Director	Kassem Bazzi
43	MRAD (DSP)		Board Director	Mohamad M
44	BUS (DSP)		Contract Manager	Sayed Abbas
45	NEUC (DSP)		Project Manager for DSP project	Joseph Semaan
46	NEUC (DSP)		Head of Energy	Carla Aoun
47	INARA (GT Global)		Vice President	David Fernandes
48	INARA (GT Global)		Chief of Party	Nadia Alami
49	INARA (GT Global)		Infrastructure Technicala Lead	Amid Sahyoun

APPENDIX-2

LIST OF COLLECTED DATA

LIST OF COLLECTED DATA

No.	Name
001	Policy paper 2019 English
002	Intermediary Report LENCC Rev 3
003	Least Cost Generation Plan Report 24_11_2021_1
004	finalrapportmasterplanupdatev9.
005	2016-12-SDGrandBeyrouth Etude Schéma Directeur EDF IN V1
006	Annexe 1 Plan semi géographique fuseaux Antelias
007	Annexe 2 Antelias Schema directeur 2030 géographique
008	Annexe 3 Plan semi géographique Beyrouth
009	Annexe 4 Plan semi geographique Chiah
010	Decon Int. Letter no. 18 dated 5-3-2020
011	Investment Plan 2019 Issue 02 Rev01
012	Network Load Forecast Plan-Issue 02-Rev01
013	Reply-Data collection report 09_06_2020 - MoEW-EDL
014	DSP-PRG-MRAD-PPG-0134
015	PRO-CRP-ASM-0002
016	Basic Data and Operating Data for HPP in Lebanon
017	Questionnaires_EDL_March 2023
018	Letter EDL 0316
019	Appendix 4-2- AMI KPIs - the Concept v14(1)
020	tarrif-new
021	tarrif-old
022	EDF report regarding the losses for 2019 and 2020
023	Questionnaires_EDL_March 2023_Power System Plan (Distribution)
024	Attachment # 1 - Functions of smart meter
025	Attachment # 2 - Reply
026	Attachment # 3 - BUS Substations' Data
027	Attachment # 4 - List of Projects
028	Letter EDL 0316 (Kadisha)
029	Letter EDL 0316 (Rechmaya-Bared-Naameh &BRSS)
030	Organization chart
031	Engineers Distribution
032	Number of staff
033	Policy paper 2019 English
034	Financial Statements
035	Audited Financial statment
036	Questionnaires_EDL_March 2023
037	Letter EDL 0316
038	INARA Fact Sheets Word- UPDATED 6032023na
039	Questionnaires_EDL_30th March 2023
040	typical Substation layout diagram
041	Substation SLD
042	DSP Project Manual - Part I - Arabic
043	DSP Project Manual Part II
044	AMI Center tender documents final version
045	AMI Center tender documents final version
046	Expenditure framework - EDL - 050719
047	Questionnaires_EDL_March 2023
048	Attachment # 1 - Functions of smart meter
049	Attachment # 2 - Reply
050	Attachment # 3 - BUS Substations' Data
051	Attachment # 4 - List of Projects
052	Attachment # 5 - MV SLD
053	Letter EDL 0316 (Kadisha)
054	Letter EDL 0316 (Rechmaya-Bared-Naameh &BRSS)

No.	Name
055	Questionnaires_EDL_March 2023 IV. Power System Plan (Distribution)
056	EDL Bussines Plan
057	LRA Material
058	EDL Short Term Financial Model (Phases I & II) - 25-09-2021
059	GZCost PP
060	Merged Data sent to IMF 23-2-2023
061	Preliminary Analysis on Transmission System Planning Report
062	Production 2015-2020 (Power Plants)
063	Production information 2019
064	Tariff Simulation & Average Revenue - 23-2-2022 JG
065	typical Substation layout diagram

APPENDIX-3

KICK-OFF MEETING FOR OCTOBER MISSION

Data Collection Survey on Electricity Sector in Lebanon

Kick-off Meeting for October Mission

October 2023

JICA Study Team

NEWJEC Kansai Transmission and Distribution

Purposes of Data Collection Survey

The purposes of this Data Collection Survey are

- to collect basic information on the current status and identify issues in relation to the electricity power sector reform; and
- to facilitate discussions and consensus building between the Lebanese counter parties and JICA on a clear direction of the technical cooperation planned in the following phase.

Three Main Pillars of Scope of Work

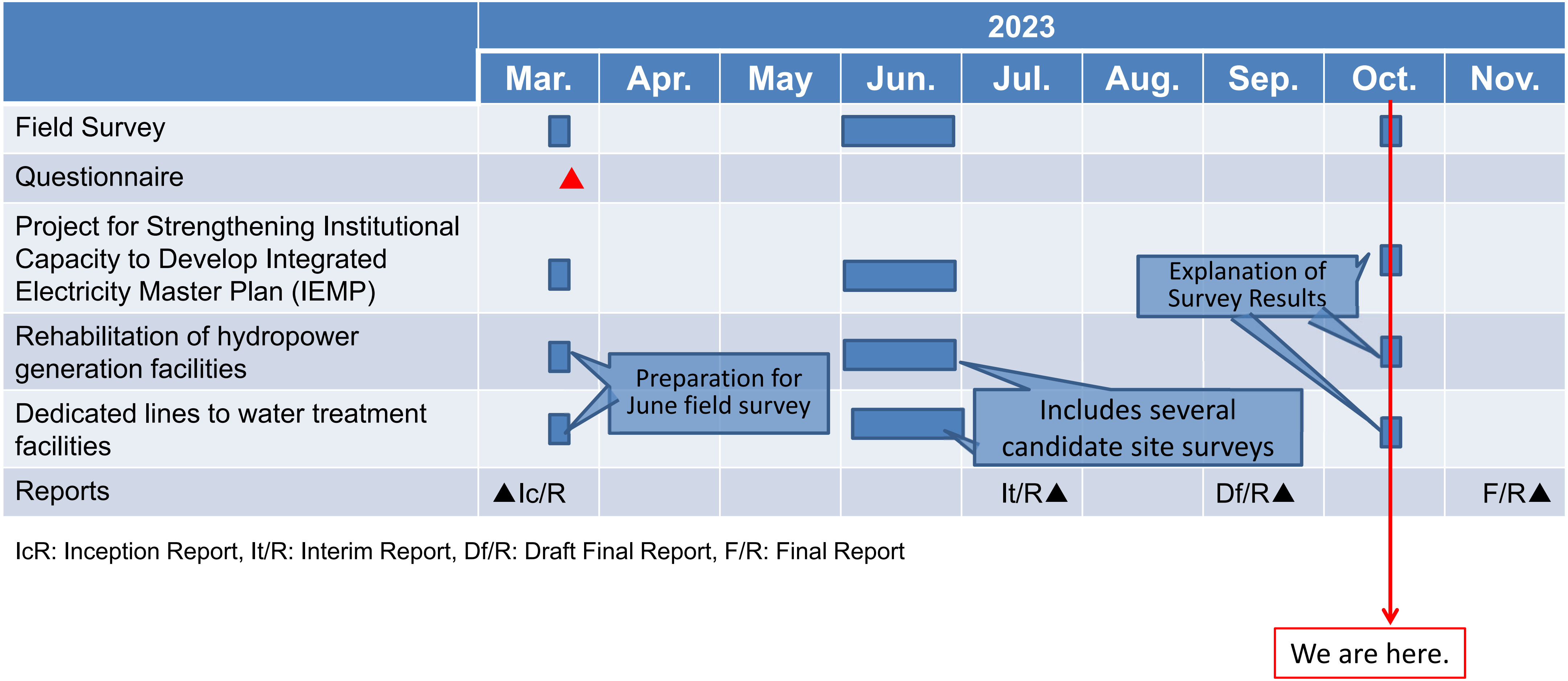
The three main pillars of scope of work are

1. to organize information on formulating a detailed plan of the technical cooperation (T/C) *"Project for Strengthening Institutional Capacity to Develop Integrated Electricity Master Plan"*;

2. to collect information on and conduct pre-feasibility study of rehabilitation of existing hydropower generation facilities under the MoEW; and

3. to collect information on and conduct pre-feasibility study of dedicated transmission lines to water treatment facilities.

Schedule of Survey



IcR: Inception Report, It/R: Interim Report, Df/R: Draft Final Report, F/R: Final Report

Member List of JICA Study Team

Project Management Group

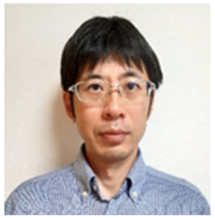
Chief Consultant ／ Power Development Plan

Kenichiro YAGI

Deputy Chief Consultant ／ Power Development Plan

Sho SHIBATA

Power Grid System (Transmission)	Power Grid System (Distribution 1)	Power Grid System (Distribution 2)	Renewable Energy	Economic and Financial Analysis	Hydroelectric Power Generation (Rehabilitation Planning)	Power Transmission and Substation (Planning and Design)	Environmental and Social Considerations / Coordinator
Kiyotaka UENO	**Kei OTSU**	**Keisuke MORITA**	**Takao SARUHASHI**	**Fukashi KUMURA**	**Itsuro MIYATA**	**Kazuo MURAI**	**Hiroki YAMAGUCHI**





Interface with the Both Counter Parties 1

Areas of expertise	Experts in JICA Study Team	MoEW	EDL	Remarks
Chief Consultant ／ Power Development Plan	Kenichiro YAGI	**Dr. Khaled Nakhle** **Dr. Ahmad** **Ms. Lamia**	**Mr. Jihad Ghadieh** **Generation department** Mr. Bshara Etieh Mr. Fadi Abo Khouzam **Hydropower Department** Mr. Fadi Abo Khozam *1 **Transmission Department** Mr.Rabih Daw, Transmission Director Mr.Ramzi El Dobeissy, Head of Transmission Department **Study Directorate** Ms.Raja El-Ali, Head Mr. Rima Assaf, Net Metering Committee and Head of Study Dep.	
Deputy Chief Consultant / Power Development Plan	Sho SHIBATA			Integrated Electricity Master Plan (IEMP)
Renewable Energy	Takao SARUHASHI	**LCEC** Mr.Pierrre El Khoury, Director General		
Power Grid System (Transmission)	Kiyotaka UENO			
Power Grid System (Distribution)	Kei OTSU, Keisuke MORITA		**Distribution (Beirut and ML) Directorate** Mr.Ibrahim Moussa: Head **Regional Distribution Directorate** Mr.Ghassam Darwich: Head **Beirut Division and AMI** Mr.Tarek Mausow: Head	

LCEC: Lebanese Center for Energy Conservation

Interface with the Both Counter Parties 2

Areas of expertise	Experts in JICA Study Team	MoEW and Related organization	EDL	Remarks
Economic and Financial Analysis	**Fukashi KUMURA**			
Hydroelectric Power Generation (Rehabilitation Planning)	**Itsuro MIYATA**	**Litani River Authority** Dr.Sami Alawieh	**Hydropower Department** Mr. Fadi Abo Khozam *1 **Kadisha River** Mr. Abdel Rahman Mawas Eng. Basem Khayat	Rehabilitation of hydropower generations
Power Transmission and Substation (Planning and Design)	**Kazuo MURAI**	**EBML** Ms.Ghada rida, Technical Director	----	Dedicated lines to water treatment facilities

EBML: EBML Water of Beirut and Mount Lebanon

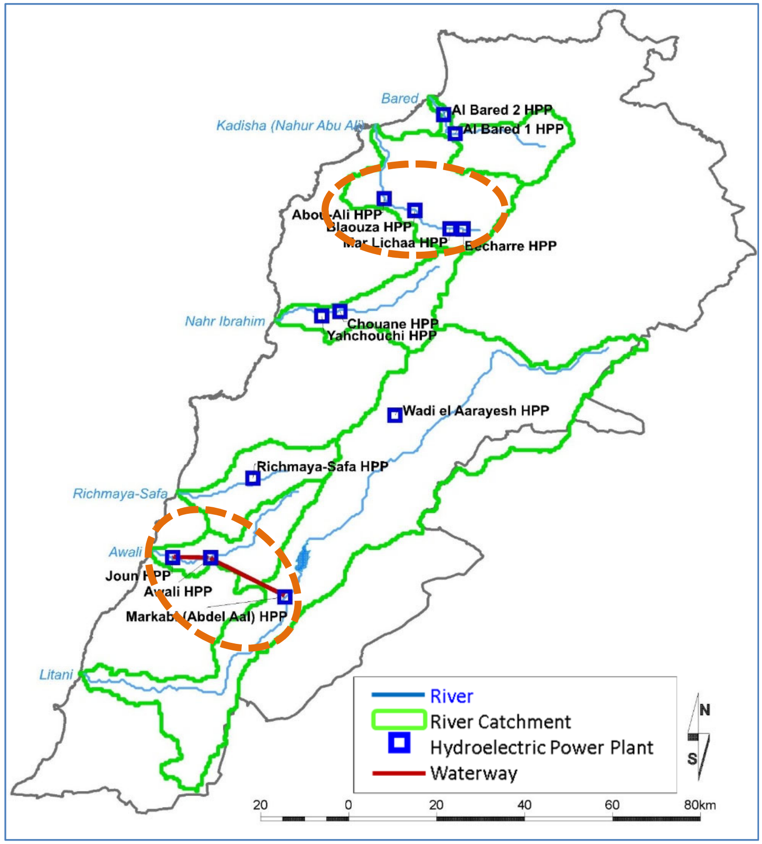
Rehabilitation of Hydropower Generation Facilities

Rehabilitation of Hydropower Generation Facilities

Specifications of Hydropower Plants

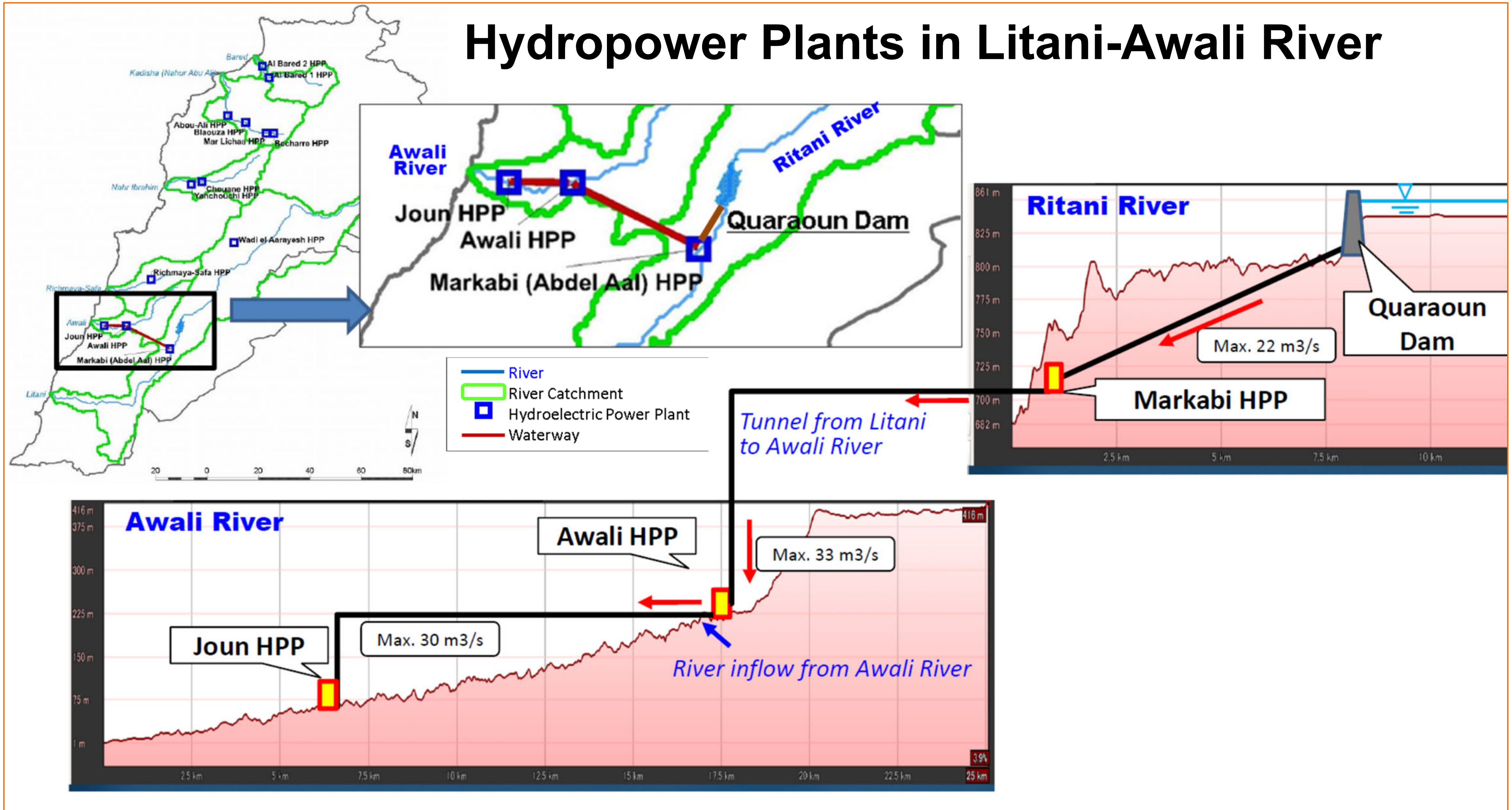
	River System	Company	Rated Capacity (MW)	Result of March Mission
1	**Litani**	Litani Water Authority	199	Operated by LRA (Litani River Authority). (Meeting with LRA in Beirut on 21th March)
2	**Kadisha**	Kadisha Company (EDL owned)	22	Operated by Kadischa-EDL. (Meeting with Hydropower Department of EDL headquarter on 20th March)
3	**Al Bared**	Al Bared concession (EDL owned)	17	UNDP is under study to renovate the facility. (Meeting with UNDP on 21th March)
4	**Nahr Ibrahim**	Nahr Ibrahim Company	34	Operated by IPP.
5	**Safa spring**	EDL	13	MCC is preparing to renovate the facility. (Meeting with USAID on 24th March)
Total			285	

Existing Hydropower Plants Location

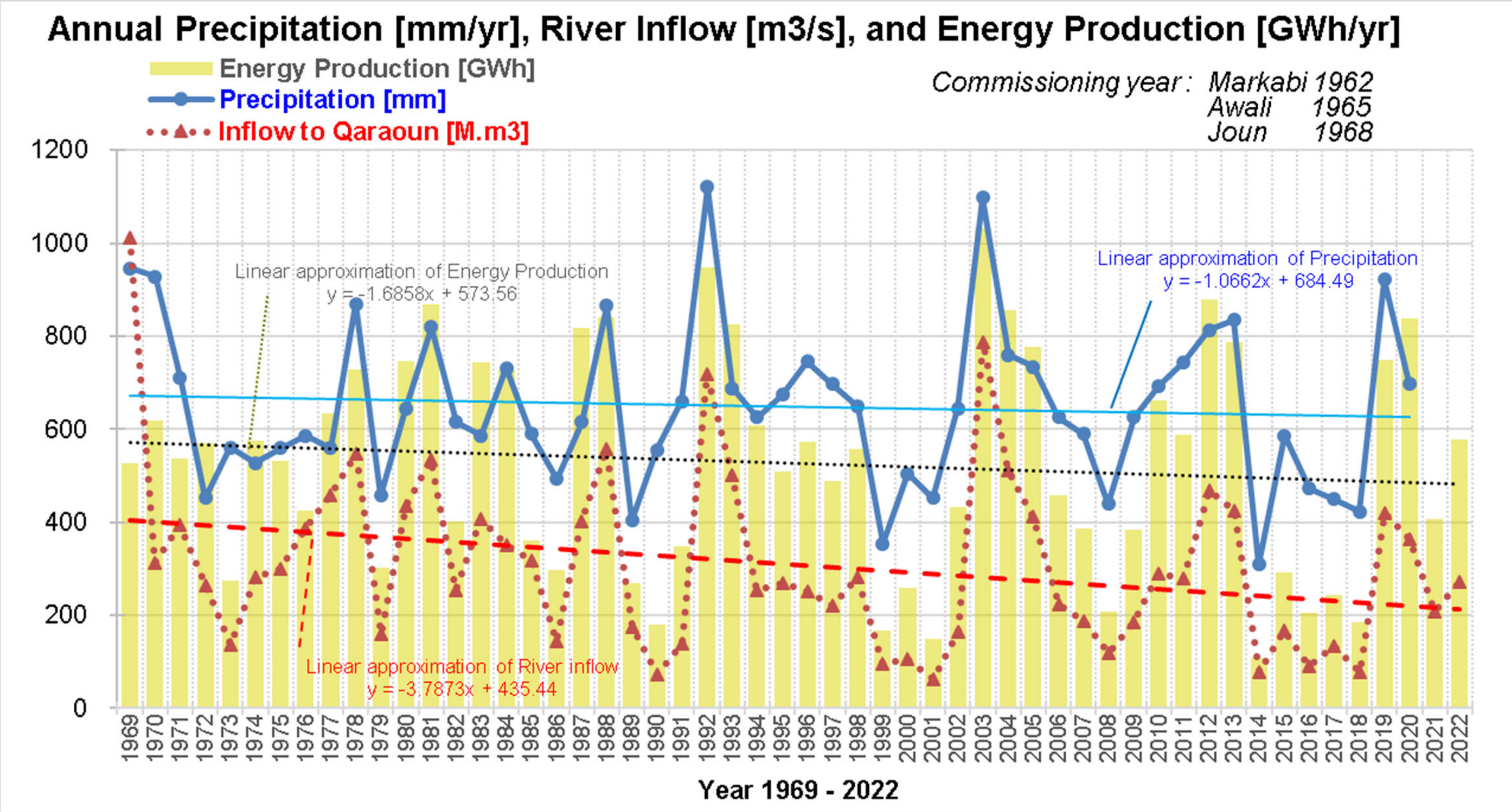


Litani and Kadisha are selected as the candidate sites for site survey on June 2023.

Rehabilitation of Hydropower Generation Facilities

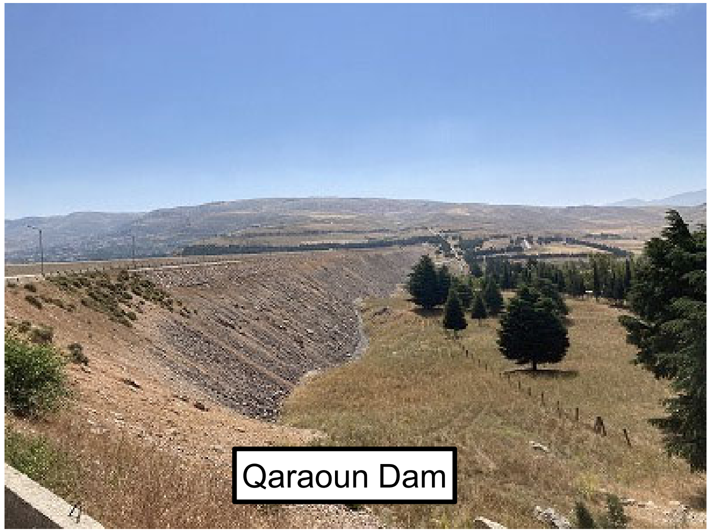


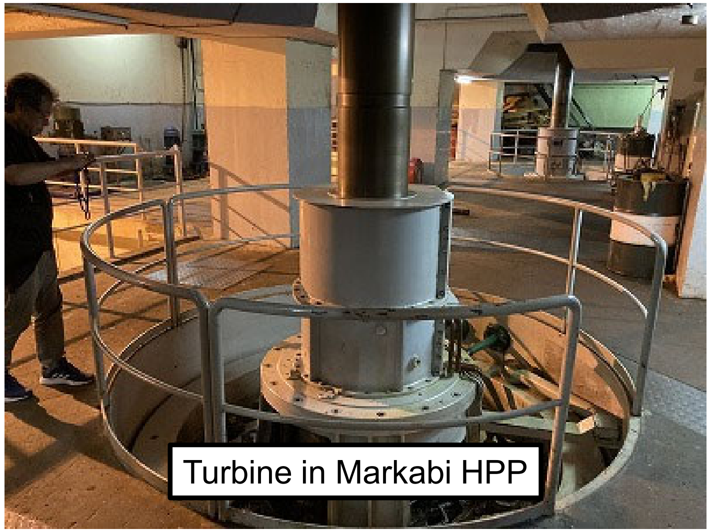
Rehabilitation of Hydropower Generation Facilities



Rehabilitation of Hydropower Generation Facilities

Site Visit to Qaraoun Dam/Markabi Hydropower Plant (June 12th, 2023)/Litani


Qaraoun Dam

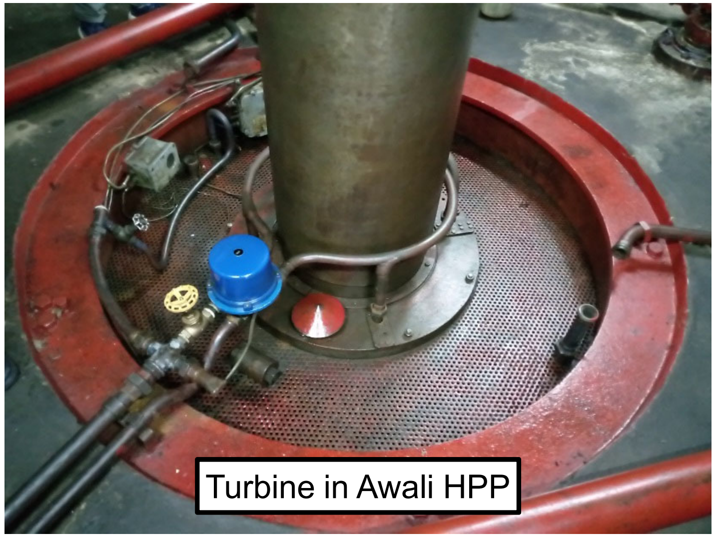

Turbine in Markabi HPP

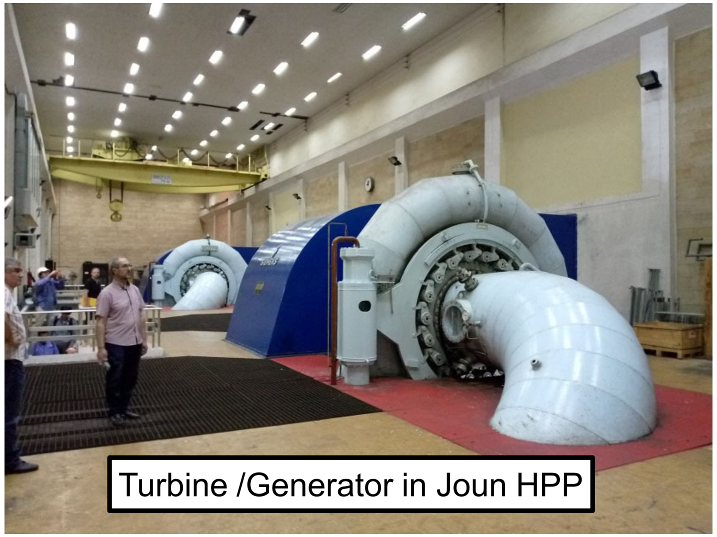

Discussion with LRA

- Confirmation on Data and Site Situation of Qaraoun Dam
- Site Visit for Current Conditions of Facilities in Markabi Hydropower Plant
- Explanation of Analysis Result for 10 Year Operation Data (Generation/Operating Hours) to LRA
- Discussion/Recommendation on Rehabilitated Facilities and Critical Components requiring Upgrade

Rehabilitation of Hydropower Generation Facilities

Site Visit to Joun & Awali Hydropower Plants (June 13th, 2023)/Litani





- Confirmation on Configuration of all Hydropower Plants in Litani River
- Site Visit for Current Conditions of Facilities in Joun & Awali Hydropower Plants
- Explanation of Analysis Result for 10 Year Operation Data (Generation/Operating Hours) to LRA
- Discussion/Recommendation on Rehabilitated Facilities and Critical Components requiring Upgrade

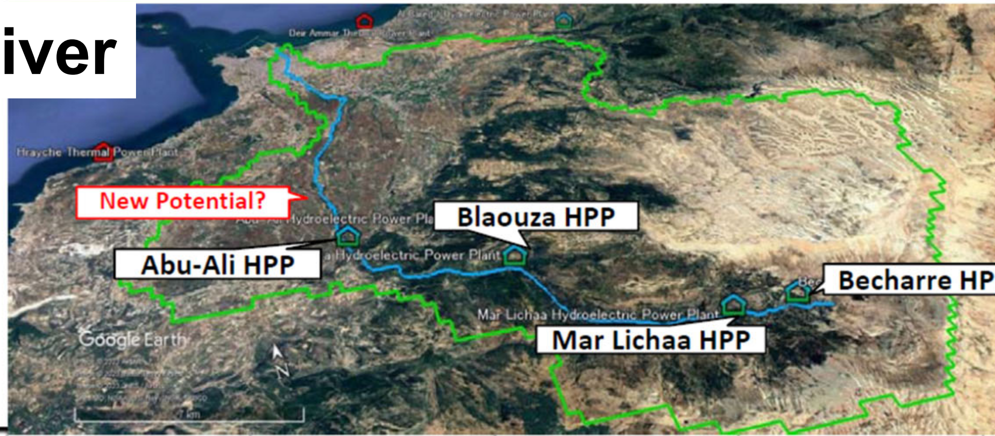
Rehabilitation of Hydropower Generation Facilities

Scope of Rehabilitation Works for Hydropower Plants in Litani

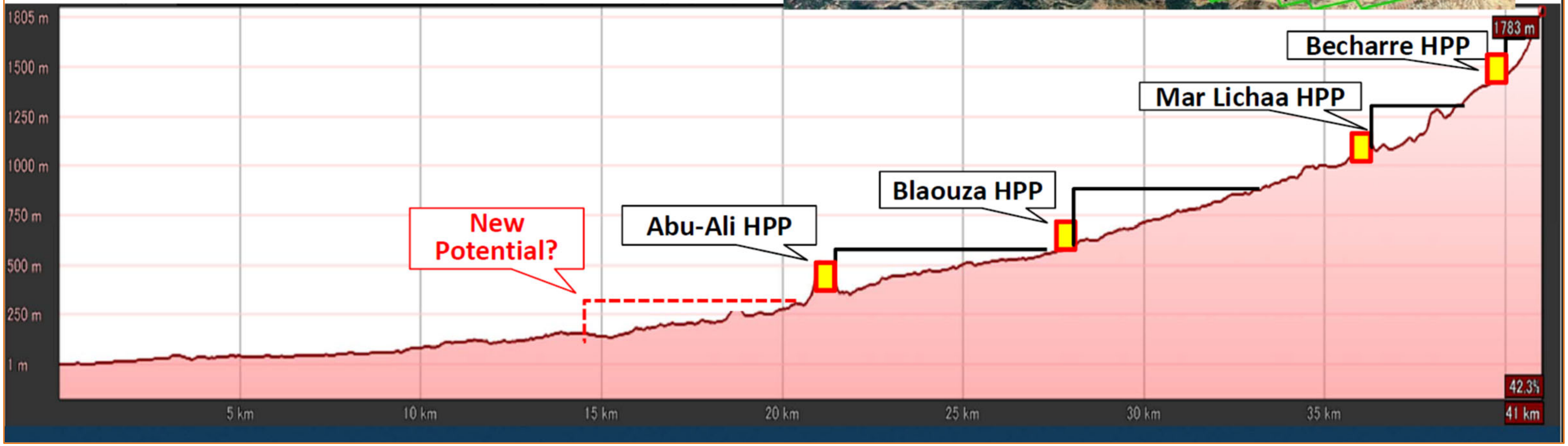
Name of Hydropwer Plant		Critical Components requiring upgrade (by LRA)			
		Equipment/Parts		Common Facility	
MARKABI HPP **36MW (2 x 18MW)** **Vertical Francis Turbine** **Original Manufactrer: Andriz Hydro**	Unit 1	(1)	New Governor systems for Two (2) Francis Turbines and related mechanical and electrical equipment (existing one since 1995)	(1)	New SCADA System for Two 82) units, New High Voltage Substation 66kV and Medium Voltage Substation 15kV (existing one since 2000)
				(2)	New Protection Systems for Three (3) lines 66kV (existing one since 1962)
	Unit 2			(3)	New 400VAC Distribution Panel
				(4)	Two (2) New Inlet Valves (Bi-plane Valves) (Optional Item)
AWALI HPP **108MW (3 x 36MW)** **Vertical 5 Jet-Pelton Turbine** **Original Manufacturer: GE Renewable**	Unit 1	(1)	New Governor systems for Three (3) Pelton Turbines each)and related mechanical and electrical equipment (existing one since 1995)	(1)	New SCADA System for Three (3) units, New High Voltage Substation 66kV and Medium Voltage Substation 15kV (existing one since 1965)
		(2)	New Protection Systems for Thre (3) Generators (45MVA each) (existing ones since 1965)	(2)	New Protection Systems for Six (6) lines 66kV (existing one since 1965)
	Unit 2	(3)	New Automatic Voltage Regulators (AVR) for Three (3) Generators (45MVA each) (existing ones since 1995)		
		(4)	New Protection Systems for Thre (3) Step-up Transformers (45MVA each) (existing ones since 1965)		
	Unit 3	(5)	New Runners for Three (3) Pelton Turbines each) and Rehabilitation of Turbine Nozzles		
		(6)	Maintenance of Three (3) Inlet Valves		
JOUN HPP **48MW (2 x 24MW)** **Horizontal Francis Turbine** **Original Manufacturer: Voith/Siemens Hydro**	Unit 1	(1)	New Governor systems for Two (2) Francis Turbines and related mechanical and electrical equipment (existing one since 1995)	(1)	Two (2) New Inlet Valves (Bi-plane Valves) (Optional Item)
		(2)	Maintenance of Two (2) Generators		
	Unit 2	(3)	Maintenance of Two (2) Inlet Valves (Spherical Valves) including replacement of sealing materials		

Rehabilitation of Hydropower Generation Facilities

Hydropower Plants in Kadisha River

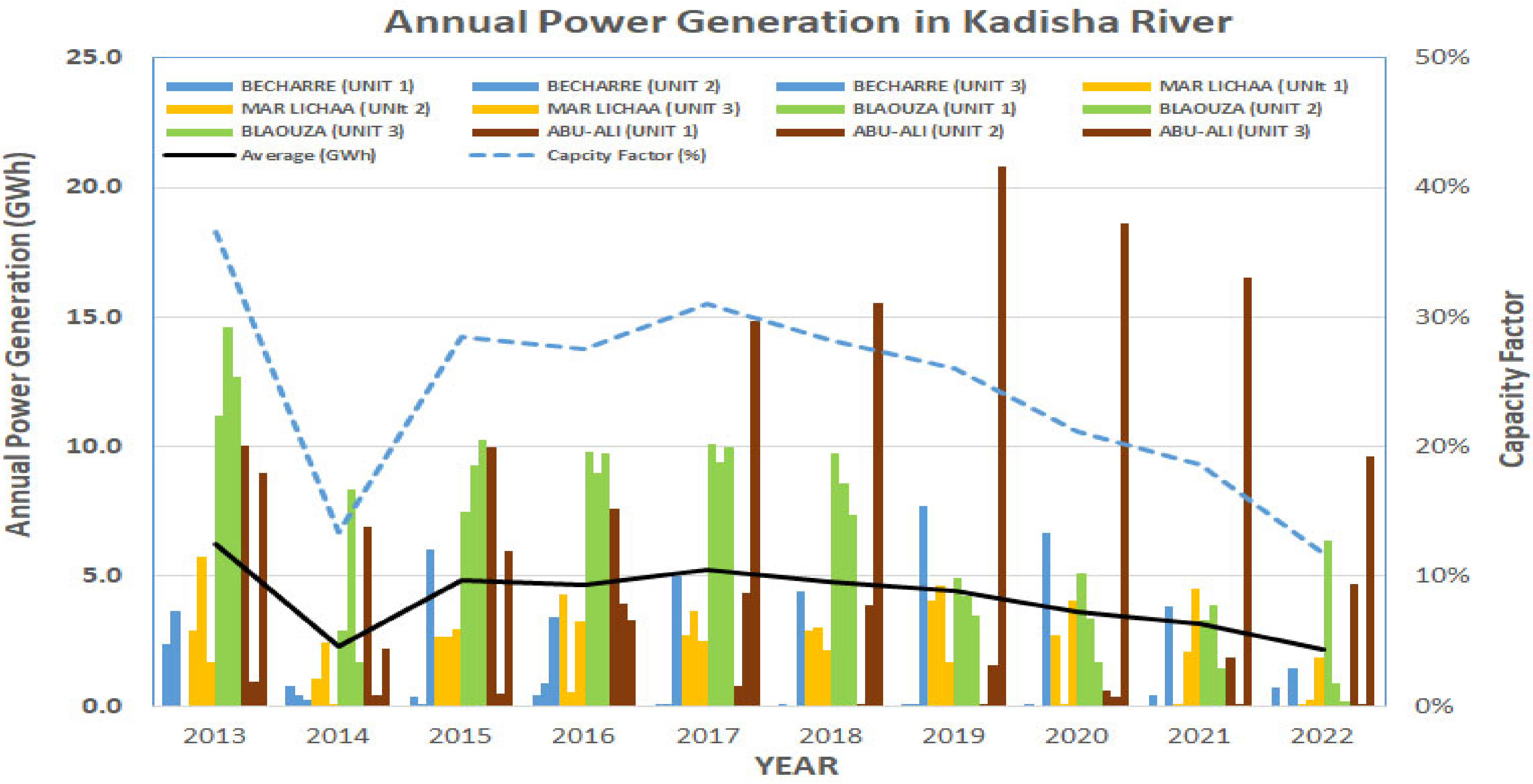


Kadisha River (Nahur Abu Ali)



Rehabilitation of Hydropower Generation Facilities

Year 2013 to 2022



Rehabilitation of Hydropower Generation Facilities

Site Visit to Becharre/Mari Lichaa Hydropower Plants (June 15th, 2023)/Kadisha

Additional New Turbine/Generator of Becharre HPP

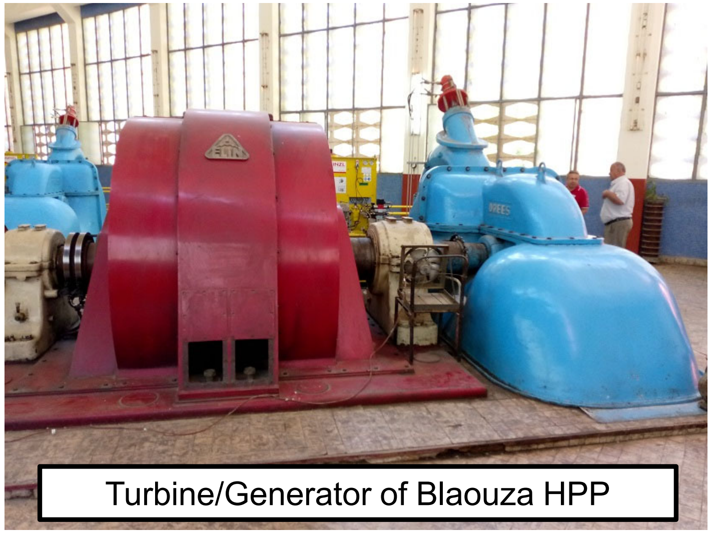
New Control Panels of Becharre HPP

Turbine/Generator of Mari Lichaa HPP

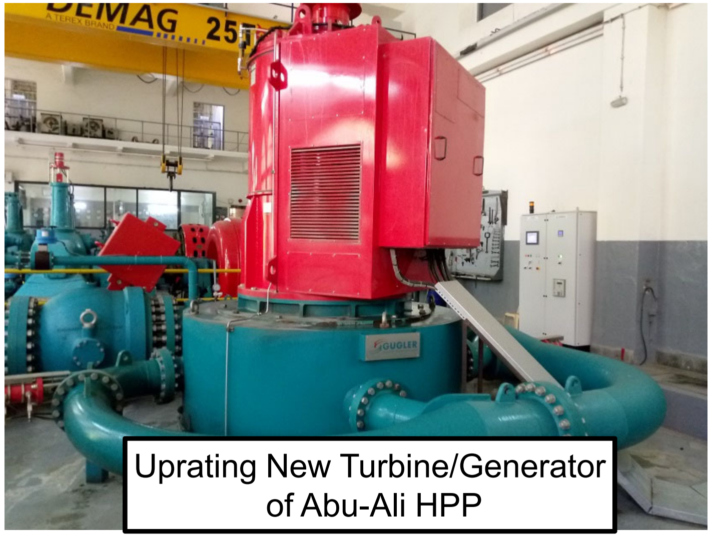
- Explanation of Analysis Result for 10 Year Operation Data (Generation/Operating Hours) to Kadisha
- Confirmation on Configuration of all Hydropower Plants in Kadisha
- Site Visit for Current Conditions of Facilities in Becare & Mari Lichaa Hydropower Plants
- Discussion on Rehabilitated Facilities

Rehabilitation of Hydropower Generation Facilities

Site Visit to Blaouza/Abu-Ali Hydropower Plants (June 16th, 2023)/Kadisha



Turbine/Generator of Blaouza HPP



Uprating New Turbine/Generator of Abu-Ali HPP

Kousba Substation

- ➢ Site Visit for Current Conditions of Facilities in Blaouza & Abu-Ali Hydropower Plants
- ➢ Discussion on Rehabilitated Facilities
- ➢ Visit Kousba Substation for Confirmation of Network System in Kadisha Area

Rehabilitation of Hydropower Generation Facilities

Rehabilitated Facilities for Hydropower Plants in Kadisha

Name of Hydropower Plant		Rehabilitation executed			Critical Components requiring upgrade (by Kadisha)	
		Year	Equipment/Parts	Common Facility	Equipment/Parts	Common Facility
BECHARRE HPP 3.44MW (2 x 0.8MW + 1 x 1.8MW) Pelton Turbine	Unit 1	---	Original Facilities (No Regabilitation)	Rehabilitation of Units: Starting Date : March 6, 2014 Fnishing Date : December 15, 2014 - New Common Control Panel - New Overhead Crane (12.5T +2T) * One (1) New Turbine Runner (spare)	Major Electrical Facilities and related equipment already rehabilitated (except Unit 1)	- Shortage of Spare Parts - Battery Facility (110VDC)
	Unit 2	2014	New Turbine Runner			
		2014	New Inlet Vlve and Oil Pressure Supply System			
		2014	New Unit Control Panel			
	Unit 3 (additional)	2014	Additional: New Vertical 4-Jet Pelton Turbine /Gnenerator (Uprating 1,844kW) :GUGLER			
		2014	New Inlet Valve and Oil Pressure Supply System			
		2014	New Unit Control Panel			
MAR LICHAA HPP 3.12MW (3 x 1.04MW) Pelton Turbine	Unit 1	1996	New Turbine Runner	Rehabilitation of Units: Starting Date : July 15, 2014 Fnishing Date : February 25, 2016 - New Common Control Panel - New Overhead Crane (16T + 2T) * Two (2) New Turbine Runners (spare)	Major Electrical Facilities and related equipment already rehabilitated.	- Shortage of Spare Parts - Battery Facility (110VDC)
		2014 - 2016	New Inlet Valve and Oil Pressure Supply System			
		2014 - 2016	New Unit Control Panel			
	Unit 2	1996	New Turbine Runner			
		2014 - 2016	New Inlet Valve and Oil Pressure Supply System			
		2014 - 2016	New Unit Control Panel			
	Unit 3	1996	New Turbine Runner			
		2014 - 2016	New Inlet Valve and Oil Pressure Supply System			
		2014 - 2016	New Unit Control Panel			
BLAOUZA HPP 8.4MW (3 x 2.8MW) Pelton Turbine	Unit 1	2014 - 2016	New Turbine Runner	Rehabilitation of Units: Starting Date : July 15, 2014 Fnishing Date : February 25, 2016 - New Common Control Panel * New Turbine Runners (spare)	Major Electrical Facilities and related equipment already rehabilitated.	- Shortage of Spare Parts - Battery Facility (110VDC)
		2014 - 2016	New Inlet Valve and Oil Pressure Supply System			
		2014 - 2016	New Unit Control Panel			
	Unit 2	2014 - 2016	New Turbine Runner			
		2014 - 2016	New Inlet Valve and Oil Pressure Supply System			
		2014 - 2016	New Unit Control Panel			
	Unit 3	2014 - 2016	New Turbine Runner			
		2014 - 2016	New Inlet Valve and Oil Pressure Supply System			
		2014 - 2016	New Unit Control Panel			
ABU-ALI HPP 7.48MW (2 x 2.72MW + 1 x 3.5MW) Pelton Turbine	Unit 1	---	Original Facilities (No Regabilitation)	Rehabilitation of Units: Starting Date : March 6, 2015 Fnishing Date : November 28, 2018 - New Common Control Panel - New Overhead Crane (25T) * Two (2) Turbine Runner (spare)	Major Electrical Facilities and related equipment already rehabilitated (except Unit 1)	- Shortage of Spare Parts - Batery Facility (110VDC)
	Unit 2	2015 - 2018	New Turbine Runner			
		2015 - 2018	New Inlet Valve and Oil Pressure Supply System			
		2015 - 2018	New Unit Control Panel			
	Unit 3	2015 - 2018	New Vertical 4-Jet Pelton Turbine /Generator (Uprating 3,639kW) :GUGLER			
		2015 - 2018	New Inlet Valve and Oil Pressure Supply System			
		2015 - 2018	New Unit Control Panel			

Rehabilitation of Hydropower Generation Facilities

Implementation Schedule of Rehabilitation Works for Hydropower Plants in Litani

Implementation Schedule for Markabi HPP

Name of HPP	Equipment/Parts		Month																			Remarks
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
MARKABI HPP	Unit 1	New Governor system for Francis Turbines and related mechanical and electrical equipment	Procurement			Design/Manufacturing/Delivery						Installation										
	Unit 2	New Governor system for Francis Turbines and related mechanical and electrical equipment	Procurement			Design/Manufacturing/Delivery							Installation									
	Unit 1	New Inlet Valve (Bi-plane Valve) (Optional Item)	Procurement			Design/Manufacturing/Delivery								Installation								
	Unit 2	New Inlet Valve (Bi-plane Valve) (Optional Item)	Procurement			Design/Manufacturing/Delivery									Installation							
	Common	New SCADA System for 2 units, New High Voltage Substation 66kV and Medium Voltage Substation 15kV	Procurement			Design/Manufacturing/Delivery								Installation								
		New Protection Systems for 3 lines 66kV	Procurement			Design/Manufacturing/Delivery					Installation											
		New 400VAC Distribution Panel	Procurement			Design/Manufacturing/Delivery					Installation											

Rehabilitation of Hydropower Generation Facilities

Implementation Schedule of Rehabilitation Works for Hydropower Plants in Litani

Implementation Schedule for Awali HPP

Name of HPP	Equipment/Parts		Month																			Remarks
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
AWALI HPP	Unit 1	New Runners for Pelton Turbines and Rehabilitation of Turbine Nozzles	Procurement			Design/Manufacturing/Delivery												Installation				Original Manufacturer
	Unit 2	New Runners for Pelton Turbines and Rehabilitation of Turbine Nozzles	Procurement			Design/Manufacturing/Delivery													Installation			Original Manufacturer
	Unit 3	New Runners for Pelton Turbines and Rehabilitation of Turbine Nozzles	Procurement			Design/Manufacturing/Delivery														Installation		Original Manufacturer
	Unit 1	Maintenance of Inlet Valve	Procurement			Design/Manufacturing/Delivery												Installation				Original Manufacturer Same timing with installation of Unit 1 runner/repairing turbine nozzles
	Unit 2	Maintenance of Inlet Valve	Procurement			Design/Manufacturing/Delivery													Installation			Original Manufacturer Same timing with installation of Unit 2 runner/repairing turbine nozzles
	Unit 3	Maintenance of Inlet Valve	Procurement			Design/Manufacturing/Delivery														Installation		Original Manufacturer Same timing with installation of Unit 3 runner/repairing turbine nozzles
	Unit 1	New Automatic Voltage Regulator (AVR) for Generators (45MVA)	Procurement			Design/Manufacturing/Delivery						Installation										
	Unit 2	New Automatic Voltage Regulator (AVR) for Generators (45MVA)	Procurement			Design/Manufacturing/Delivery						Installation										
	Unit 3	New Automatic Voltage Regulator (AVR) for Generators (45MVA)	Procurement			Design/Manufacturing/Delivery							Installation									
	Unit 1	New Protection System for Generator (45MVA)	Procurement			Design/Manufacturing/Delivery						Installation										
	Unit 2	New Protection System for Generator (45MVA)	Procurement			Design/Manufacturing/Delivery						Installation										
	Unit 3	New Protection System for Generator (45MVA)	Procurement			Design/Manufacturing/Delivery							Installation									
	Unit 1	New Protection Systems for Step-up Transformer (45MVA)	Procurement			Design/Manufacturing/Delivery						Installation										
	Unit 2	New Protection Systems for Step-up Transformer (45MVA)	Procurement			Design/Manufacturing/Delivery						Installation										
	Unit 3	New Protection Systems for Step-up Transformer (45MVA)	Procurement			Design/Manufacturing/Delivery							Installation									
	Common	New SCADA System for Three (3) units, New High Voltage Substation 66kV and Medium Voltage Substation 15kV	Procurement			Design/Manufacturing/Delivery								Installation								
		New Protection Systems for 6 lines 66kV	Procurement			Design/Manufacturing/Delivery						Installation										

Rehabilitation of Hydropower Generation Facilities

Implementation Schedule of Rehabilitation Works for Hydropower Plants in Litani

<u>Implementation Schedule for Joun HPP</u>

Name of HPP	Equipment/Parts		Month																			Remarks
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
JOUN HPP	Unit 1	New Governor system for Francis Turbine and related mechanical and electrical equipment		Procurement				Design/Manufacturing/Delivery				Installation										
	Unit 2	New Governor system for Francis Turbine and related mechanical and electrical equipment		Procurement				Design/Manufacturing/Delivery					Installation									
	Unit 1	Maintenance of Inlet Valve (Spherical Valve) including replacement of sealing materials		Procurement			Design/Manufacturing/Delivery			Installation												Original Manufacturer
	Unit 2	Maintenance of Inlet Valve (Spherical Valve) including replacement of sealing materials		Procurement			Design/Manufacturing/Delivery				Installation											Original Manufacturer
	Unit 1	New Inlet Valve (Bi-plane Valve) (Optional Item)		Procurement					Design/Manufacturing/Delivery						Installation							
	Unit 2	New Inlet Valve (Bi-plane Valve) (Optional Item)		Procurement					Design/Manufacturing/Delivery							Installation						
	Unit 1	Maintenance of Generator		Procurement			Design/Manufacturing/Delivery			Installation												Original Manufacturer
	Unit 2	Maintenance of Generator		Procurement			Design/Manufacturing/Delivery				Installation											Original Manufacturer

Rehabilitation of Hydropower Generation Facilities

Estimated Cost of Rehabilitation for Hydropower Plants in Litani River

Name of HPP		Equipment/Parts	Estimated Cost USD	Estimated Cost equivalent to K-JPY
			JPY/USD=	148
MARKABI HPP	Unit 1	New Governor system for Francis Turbines and related mechanical and electrical equipment	800,000	118,400
	Unit 2	New Governor system for Francis Turbines and related mechanical and electrical equipment		
	Unit 1	New Inlet Valve (Bi-plane Valve) (Optional Item)	470,000	69,560
	Unit 2	New Inlet Valve (Bi-plane Valve) (Optional Item)		
	Common	New SCADA System for 2 units, New High Voltage Substation 66kV and Medium Voltage Substation 15kV	2,500,000	370,000
		New Protection Systems for 3 lines 66kV	350,000	51,800
		New 400VAC Distribution Panel	200,000	29,600
		TOTAL for MARKABI HPP	**4,320,000**	**639,360**
AWALI HPP	Unit 1	New Runners for Pelton Turbines and Rehabilitation of Turbine Nozzles	3,900,000	577,200
	Unit 2	New Runners for Pelton Turbines and Rehabilitation of Turbine Nozzles		
	Unit 3	New Runners for Pelton Turbines and Rehabilitation of Turbine Nozzles		
	Unit 1	Maintenance of Inlet Valve	900,000	133,200
	Unit 2	Maintenance of Inlet Valve		
	Unit 3	Maintenance of Inlet Valve		
	Unit 1	New Automatic Voltage Regulator (AVR) for Generators (45MVA)	750,000	111,000
	Unit 2	New Automatic Voltage Regulator (AVR) for Generators (45MVA)		
	Unit 3	New Automatic Voltage Regulator (AVR) for Generators (45MVA)		
	Unit 1	New Protection System for Generator (45MVA)	300,000	44,400
	Unit 2	New Protection System for Generator (45MVA)		
	Unit 3	New Protection System for Generator (45MVA)		
	Unit 1	New Protection Systems for Step-up Transformer (45MVA)	300,000	44,400
	Unit 2	New Protection Systems for Step-up Transformer (45MVA)		
	Unit 3	New Protection Systems for Step-up Transformer (45MVA)		
	Common	New SCADA System for Three (3) units, New High Voltage Substation 66kV and Medium Voltage Substation 15kV	5,000,000	740,000
		New Protection Systems for 6 lines 66kV	600,000	88,800
		TOTAL for AWALI HPP	**11,750,000**	**1,739,000**
JOUN HPP	Unit 1	New Governor system for Francis Turbine and related mechanical and electrical equipment	800,000	118,400
	Unit 2	New Governor system for Francis Turbine and related mechanical and electrical equipment		
	Unit 1	Maintenance of Inlet Valve (Spherical Valve) including replacement of sealing materials	900,000	133,200
	Unit 2	Maintenance of Inlet Valve (Spherical Valve) including replacement of sealing materials		
	Unit 1	New Inlet Valve (Bi-plane Valve) (Optional Item)	500,000	74,000
	Unit 2	New Inlet Valve (Bi-plane Valve) (Optional Item)		
	Unit 1	Maintenance of Generator	250,000	37,000
	Unit 2	Maintenance of Generator		
		TOTAL for JOUN HPP	**2,450,000**	**362,600**
		Total Cost of Rehabilitation Equipment/Parts (A)	18,520,000	2,740,960
		Engineering Cost for Consultancy Services (B)	1,300,000	192,400
		TOTAL COST (A + B) for Litani River	**19,820,000**	**2,933,360**

Rehabilitation of Hydropower Generation Facilities

Estimated Cost of Rehabilitation for Hydropower Plants in Kadisha River

			JPY/USD=	148
Pos	This is the list of Spare Parts for all 4 Hydro Power Plants FOR 4 YEARS Description	Qty	Total Cost USD	Total Cost Equivalent to K-JPY
1	Phoenix contact : power supply QUINT -PS/1AC/24DC/20 Rectifier Order -No 2866776	4	4,500	666
2	NIVELCO Water level overvoltage protection unit (Nivopress NAA-102-0 Protection IP65)	6	2,200	326
3	Simens sentrom PAC 3200 LCD 96X96 MM	2	2,500	370
4	Simens PAC profibus DP sentrom FROM pac 3200 /4200	2	1,600	237
5	MTS Sensors : Temposonic E- Series 17 cm	4	13,000	1,924
7	MTS Sensors : Temposonic E- Series 20 cm	4	13,000	1,924
8	MTS Sensors : Temposonic E- Series 24 cm	8	26,000	3,848
9	MTS Sensors : Temposonic E- Series 25 cm	4	13,000	1,924
10	MTS Sensors : Temposonic E- Series 35 cm	4	13,000	1,924
11	HAINZL: Breathing Filter	5	1,000	148
12	HAINZL: Pressure Filter	5	4,000	592
13	HAINZL: Return Line Filter	5	1,500	222
14	HAINZL: Filter element 0150	10	2,300	340
15	HAINZL: Filter element 0060	10	2,300	340
16	for BLAOUZA, MAR LICHAA, BECHAREE	9	21,000	3,108
17	Brakes for unit 3 - BECHARRE (Brake caplier and disc)	1	7,000	1,036
18	Brakes for unit 3 - ABOU ALI (Brake caplier and disc)	1	9,000	1,332
19	Varistor	3	3,500	518
20	Overvoltage arrestor	3	3,500	518
21	Schneider Electric: RMCV60BD - 24 VDC	2	2,000	296
22	Schneider Electric: RMCA61BD - 24 VDC	2	2,500	370
23	Iskra SQ0214	6	12,000	1,776
24	WOODWARD Synchronizing System SPM-D	6	35,000	5,180
25	Sets of batteries 110 V DC-58 batteries 2V	4	235,000	34,780
26	Sets of charger 110 V continue	4	210,000	31,080
27	Phoenix contact : PLC-BSC-24 DC/21 ORD.-NO:29 66 016 INPUT:UN= 24VDC	50	1,500	222
28	Electro valve unit 3 - Abu-Ali HPP	2	10,000	1,480
29	Needle for old turbine at Abu-Ali HPP	4	135,000	19,980
			786,900	**116,461**

Rehabilitation of Hydropower Generation Facilities

Summary of Estimated Cost of Rehabilitation for HPPs in Litani & Kadisha Rivers

	JPY/USD=	148	
Name of HPP	**Total Cost** **USD**	**Total Cost** **Equivalent to K-JPY**	**Remarks**
Litani River			
MARKABI HPP	4,320,000	639,360	Including replacement of Inlet Valve (Optional Item)
AWALI HPP	11,750,000	1,739,000	
JOUN HPP	2,450,000	362,600	Including replacement of Inlet Valve (Optional Item)
Engineering Cost	1,300,000	192,400	
Total (for Lirani River)	19,820,000	2,933,360	
Kadisha River			
4 HPPs (Becharre, Mar Lichaa, Blaouza, Abu-Ali)	786,900	116,461	for Spare Parts and Auxiliaries
Grand Total	**20,606,900**	**3,049,821**	

Rehabilitation of Hydropower Generation Facilities

Contribution of Rehabilitation to Hydropower Plants in Litani & Kadisha Rivers

(1) Increase of Operating Factor (Operating Hours) and Capacity Factor (Power Generation) will be expected for the hydropower plants after the rehabilitation.

(2) Efficient Usage of Installed Capacity cannot be expected for the hydropower plants due to shortage of water, even if the rehabilitation is implemented.

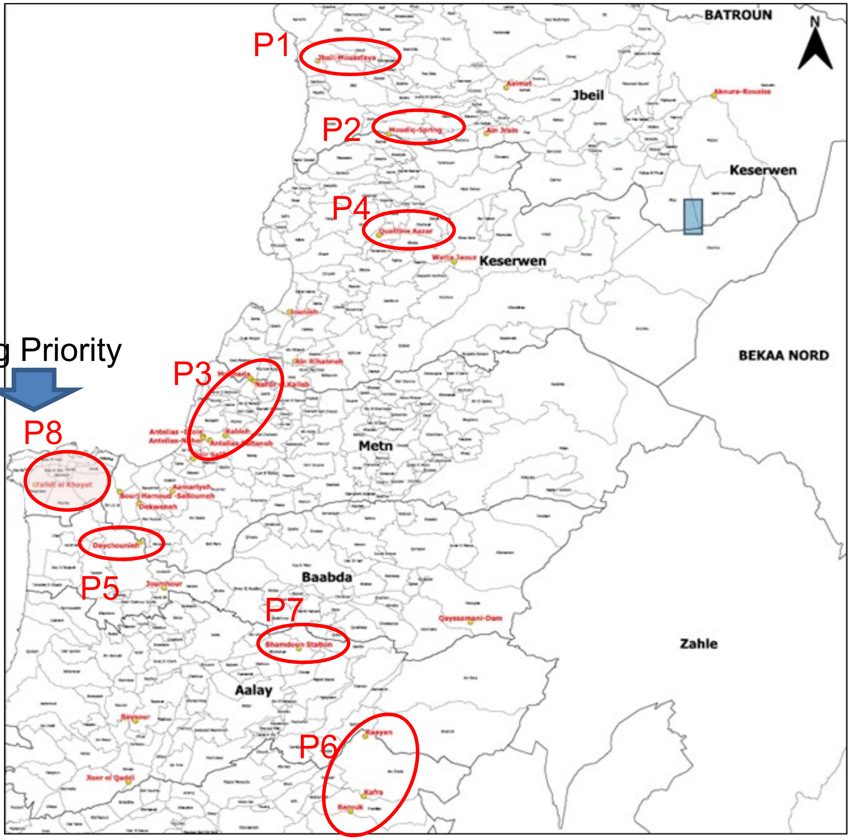
Dedicated lines to water treatment facilities

Water Treatment Facility at EBML

Result of discussion with EBML

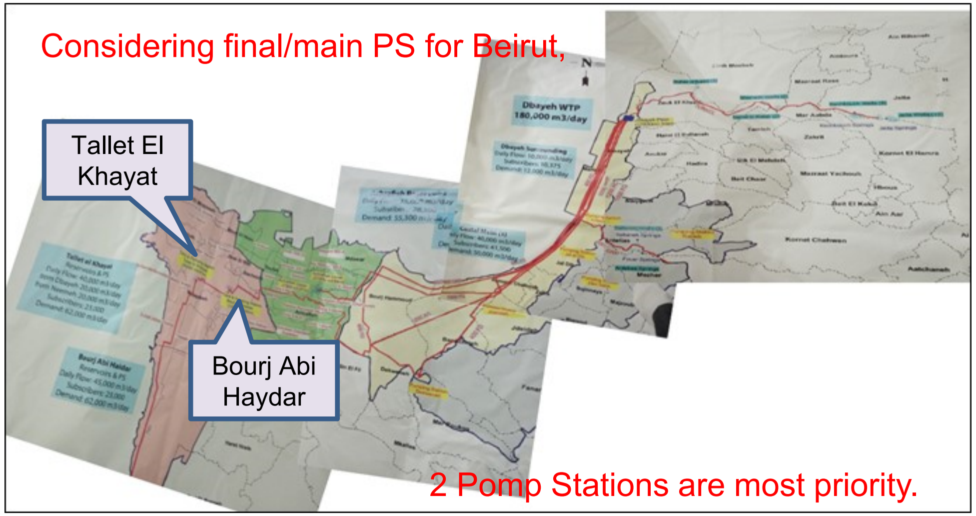
Confirming the priority based on the list of all 162 facilities provided by EBML,

Big Priority

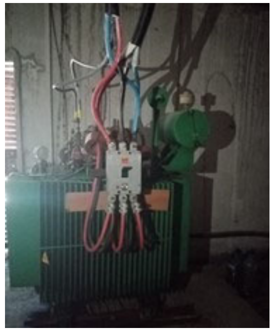


- 8 locations (14 facilities) were selected as high priority

Water Flaw Chart to Beirut

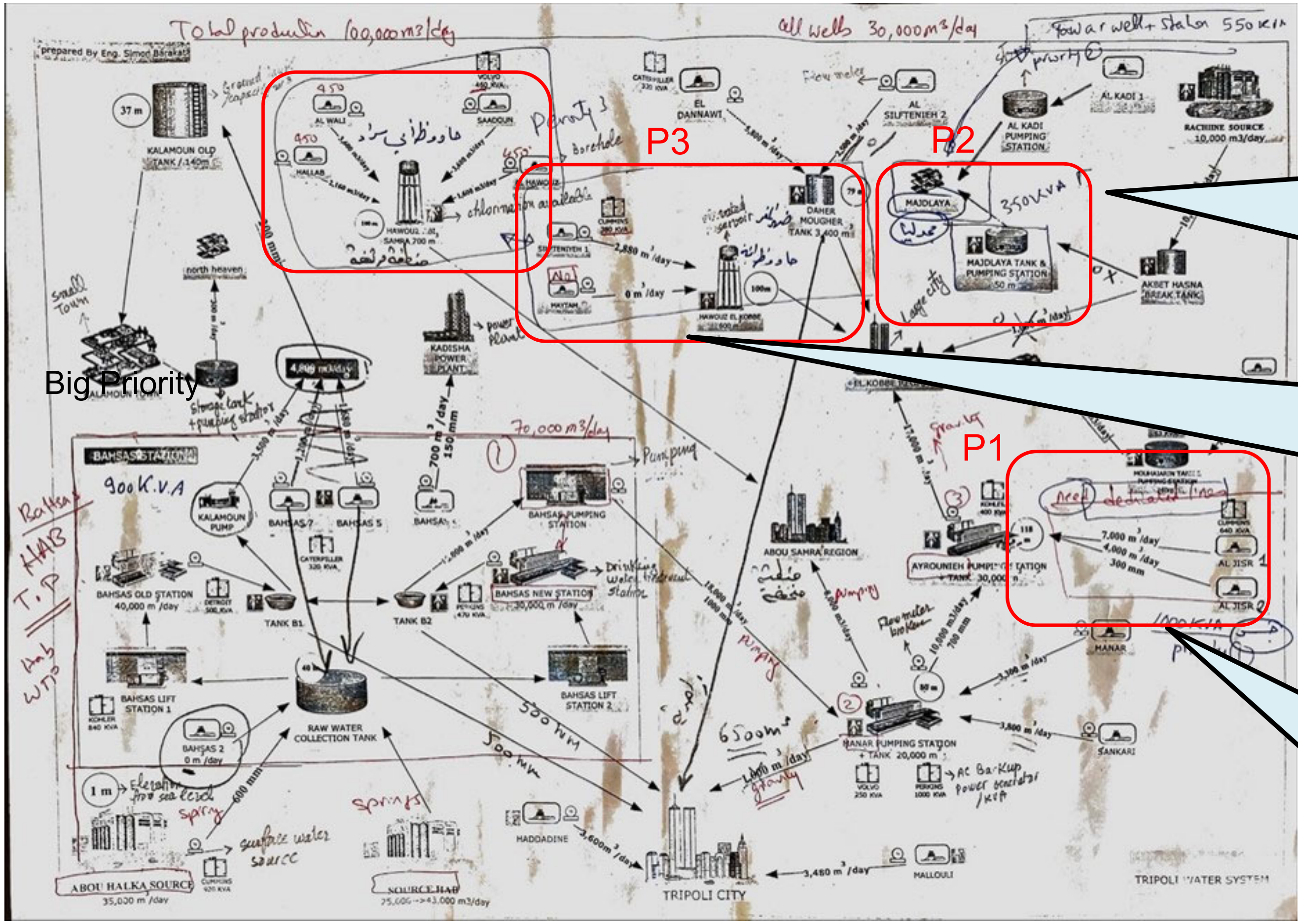


Visited at Tallet El Khayat

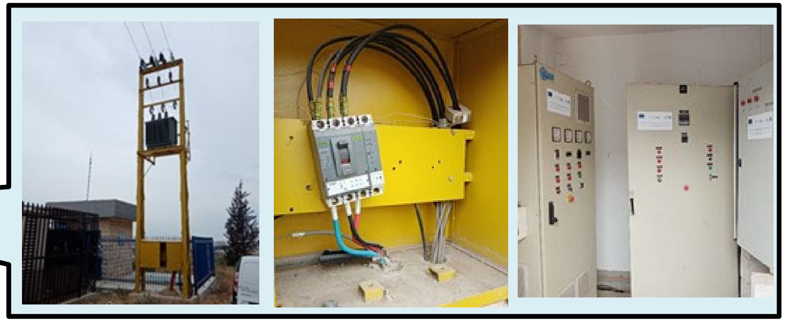


Water Treatment Facility at NLWE

Result of discussion with NLWE



Site Survey



- 3 locations (5 facilities) without dedicated lines were selected as priority

What was confirmed during the facility visit

<u>We visited each water treatment facility and confirmed the following.</u>

- There is no time to pump up because the power can only be received for a maximum 4 hours a day.
  ←→ It was confirmed that facility with a dedicated line could operate all day.
- They have a generator installed but it's not working.
- There are no particular problems with the power receiving equipment.
- There is not enough land for solar panel installation.

<u>We also visited the substation separately and confirmed the following</u>

- At the substation, power is turned on and off by feeder unit, so the problem is not due to equipment defects on the substation side.

Provisional evaluation of countermeasures

Potential countermeasures

Countermeasures	Assessment on Survey
i) New installation of a dedicated power lines from the nearest substations	Recommendation (Actually adoption and usefulness can be confirmed)
ii) Refurbishment of transmission and substation facilities	Unacceptable (The cause is not the problem of facilities, but the operational status of the feeder itself)
iii) Setting priority feeders with frequency relays at existing substations	Unacceptable (The feeder is turned on and off depending on the Substation staff)
iiii) Installation of dispersed power sources utilizing solar power, etc. within water treatment facilities (diesel generators are also available as an option)	Unacceptable (There is not enough free space for utility scale solar park in each facility.) (A diesel generator is installed but cannot be operated due to high fuel prices)

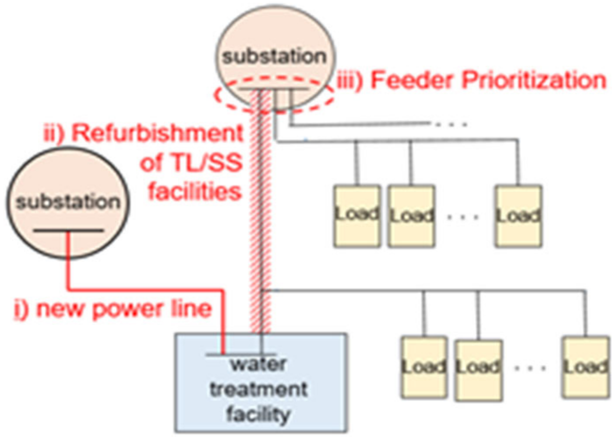


Image of transmission (distribution) lines

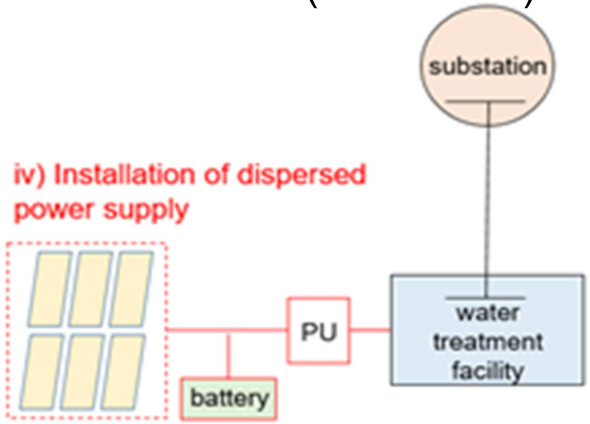
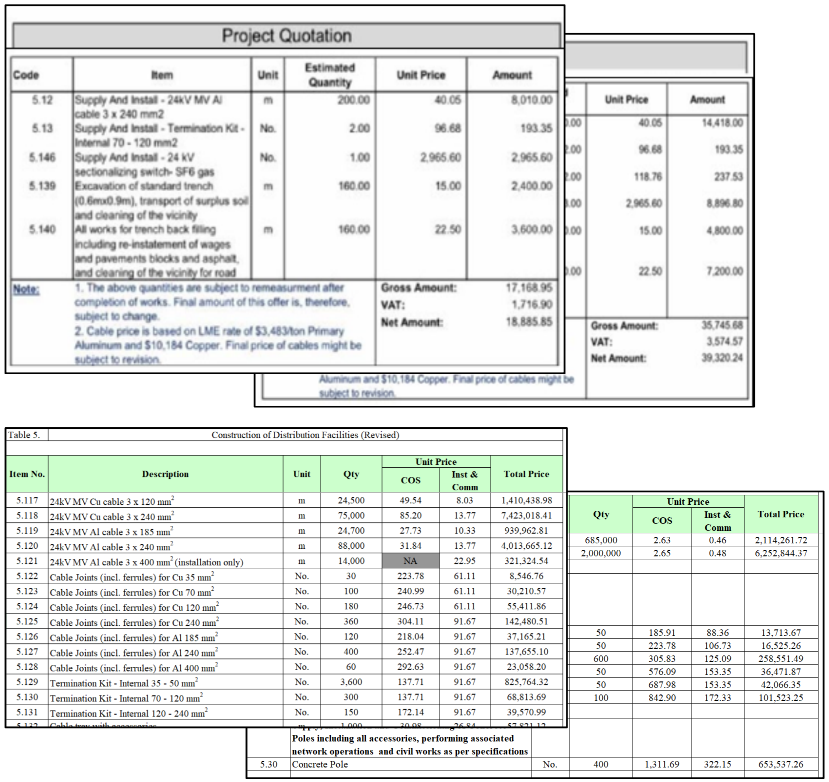


Image of dispersed power supply

Cost Estimation (Procedure)

Price for Dedicated line



Project Quotation

Code	Item	Unit	Estimated Quantity	Unit Price	Amount
5.12	Supply And Install - 24kV MV Al cable 3 x 240 mm2	m	200.00	40.05	8,010.00
5.13	Supply And Install - Termination Kit - Internal 70 - 120 mm2	No.	2.00	96.68	193.35
5.146	Supply And Install - 24 kV sectionalizing switch- SF6 gas	No.	1.00	2,965.60	2,965.60
5.139	Excavation of standard trench (0.6mx0.9m), transport of surplus soil and cleaning of the vicinity	m	160.00	15.00	2,400.00
5.140	All works for trench back filling including re-instatement of wages and pavements blocks and asphalt, and cleaning of the vicinity for road	m	160.00	22.50	3,600.00
Note:	1. The above quantities are subject to remeasurment after completion of works. Final amount of this offer is, therefore, subject to change. 2. Cable price is based on LME rate of $3,483/ton Primary Aluminum and $10,184 Copper. Final price of cables might be subject to revision.			Gross Amount:	17,168.95
				VAT:	1,716.90
				Net Amount:	18,885.85

Table 5. Construction of Distribution Facilities (Revised)

Item No.	Description	Unit	Qty	Unit Price COS	Unit Price Inst & Comm	Total Price
5.117	24kV MV Cu cable 3 x 120 mm^2	m	24,500	49.54	8.03	1,410,438.98
5.118	24kV MV Cu cable 3 x 240 mm^2	m	75,000	85.20	13.77	7,423,018.41
5.119	24kV MV Al cable 3 x 185 mm^2	m	24,700	27.73	10.33	939,962.81
5.120	24kV MV Al cable 3 x 240 mm^2	m	88,000	31.84	13.77	4,013,665.12
5.121	24kV MV Al cable 3 x 400 mm^2 (installation only)	m	14,000	NA	22.95	321,324.54
5.122	Cable Joints (incl. ferrules) for Cu 35 mm^2	No.	30	223.78	61.11	8,546.76
5.123	Cable Joints (incl. ferrules) for Cu 70 mm^2	No.	100	240.99	61.11	30,210.57
5.124	Cable Joints (incl. ferrules) for Cu 120 mm^2	No.	180	246.73	61.11	55,411.86
5.125	Cable Joints (incl. ferrules) for Cu 240 mm^2	No.	360	304.11	91.67	142,480.51
5.126	Cable Joints (incl. ferrules) for Al 185 mm^2	No.	120	218.04	91.67	37,165.21
5.127	Cable Joints (incl. ferrules) for Al 240 mm^2	No.	400	252.47	91.67	137,655.10
5.128	Cable Joints (incl. ferrules) for Al 400 mm^2	No.	60	292.63	91.67	23,058.20
5.129	Termination Kit - Internal 35 - 50 mm^2	No.	3,600	137.71	91.67	825,764.32
5.130	Termination Kit - Internal 70 - 120 mm^2	No.	300	137.71	91.67	68,813.69
5.131	Termination Kit - Internal 120 - 240 mm^2	No.	150	172.14	91.67	39,570.99

During the survey period, several materials related to cost estimation are obtained.

(Flow of cost estimation)

Step 1

- 2 PS at Beirut
- 3 Places at Tripoli

Step 2 (If necessary)

- Priority Facilities in EBML

Step 3 ~~(If necessary)~~

~~- Another Facilities in EBML and NLWE~~

At the previous wrap-up meeting, implementation of Step3 was not required.

Cost Estimation (2PS at Beirut)

(Result of cost estimation)

	Name	District	Method	Length (km)	Unit Cost (USD/km)	Total Cost (US$)
P8	Bourj Abi Haydar	Beirut	Underground Cable	0.36	ref. quotation	44,000
	Tallet El Khayat			0.20		22,000

Update Quotation

Bourji Abi Haydar

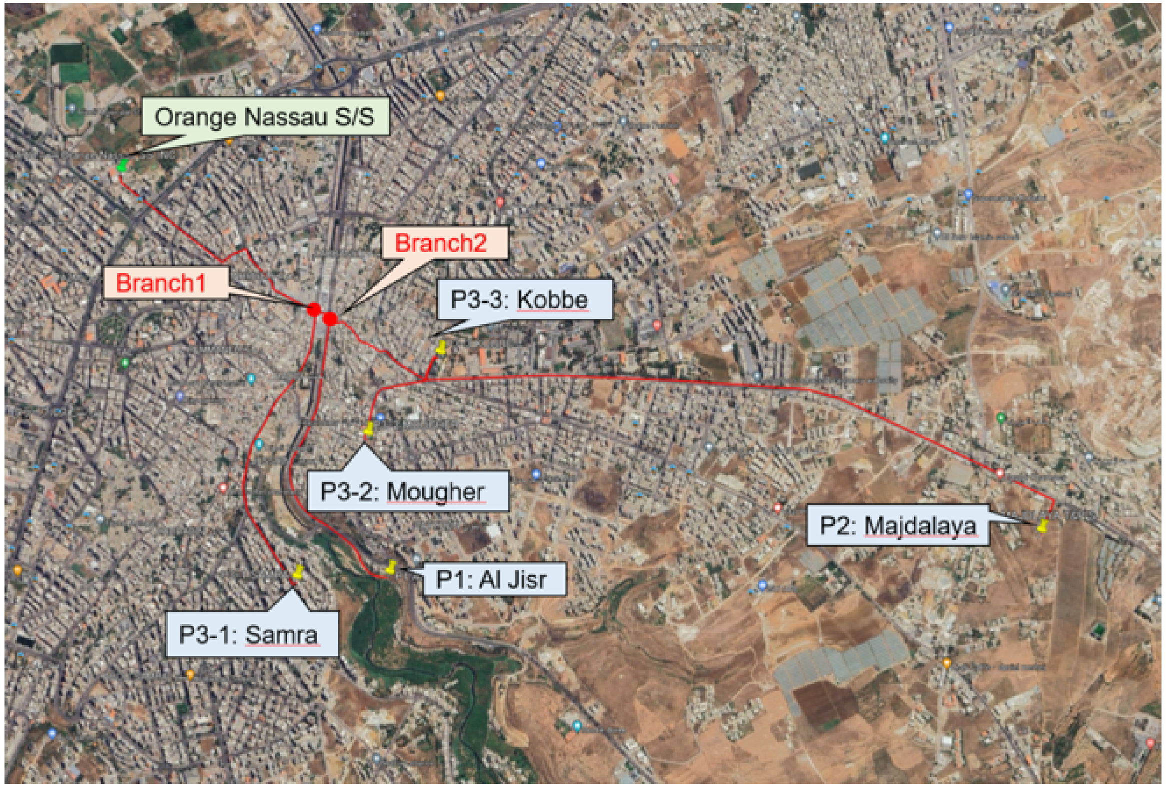
Item No.	Description	Unit	Qty	Unit Price		Total Price
				COS	Inst & Comm	
5.120	24kV MV Al cable 3 x 240 mm^2	m	360	31.84	13.77	16,419.54
5.130	Termination Kit - Internal 70 - 120 mm^2	No.	2	137.71	91.67	458.76
5.131	Termination Kit - Internal 120 - 240 mm^2	No.	2	172.14	91.67	
5.146	24 kV sectionalizing switch - SF_6 gas	No.	3	3,021.02	104.06	9,375.25
5.139	Excavation of standard trench (0.6mx0.9m), transport of surplus soil and cleaning of the vicinity	m	320	0.00	13.89	4,443.46
5.140	All works for trench back filling including re-instatement of wages and pavements blocks and asphalt, and cleaning of the vicinity for road	m	320	0.00	27.77	8,886.92
				Gross Amount		$39,583.93
				VAT		$3,958.39
				Net Amount		$43,542.32

Tallet El Khayat

Item No.	Description	Unit	Qty	Unit Price		Total Price
				COS	Inst & Comm	
5.120	24kV MV Al cable 3 x 240 mm^2	m	200	31.84	13.77	9,121.97
5.130	Termination Kit - Internal 70 - 120 mm^2	No.	2	137.71	91.67	458.76
5.146	24 kV sectionalizing switch - SF_6 gas	No.	1	3,021.02	104.06	3,125.08
5.139	Excavation of standard trench (0.6mx0.9m), transport of surplus soil and cleaning of the vicinity	m	160	0.00	13.89	2,221.73
5.140	All works for trench back filling including re-instatement of wages and pavements blocks and asphalt, and cleaning of the vicinity for road	m	160	0.00	27.77	4,443.46
				Gross Amount		$19,371.00
				VAT		$1,937.10
				Net Amount		$21,308.10

Cost Estimation (3 Places at Tripoli 1/2)

Plant Name	Al JISR/SAMRA/MOUCHER/KOBBE/MAJDLAYA
Dedicate Line Route	



From To	Orange Nassau S/S- Al JISR/SAMRA/MOUCHER/KOBBE/MAJDLAYA
Line Length	7.3 km

Preconditions for route consideration

- Orange Nassau substation is assumed to be the supply source.
- Assuming an overhead dedicated line, a dedicated line will be installed along the existing road.
- By adopting branch points, we aim to avoid increasing the track length.

Branch result

- ✓ Orange Nassau S/S – P1: Al Jisr, 2.3km
- ✓ Branch1 – P3-1: Samra, 1.2km
- ✓ Branch2 – P3-3: Kobbe, 0.6km
- ✓ P3-3: Kobbe (relay point) – P2: Majdalaya, 2.7km
- ✓ P3-3: Kobbe (relay point) – P3-2: Mougher, 0.5km

Cost Estimation (3 Places at Tripoli 2/2)

Prerequisites for unit price calculation

Calculate the construction unit price under the following conditions

- Concrete poles, installed at 50m intervals
- 24 kV MV Bundled 3 x 150 mm2 (incl. messenger wire), Drum length is 500m, Cable joints for MV bundled
- Three phase external disconnect switch with mechanical control 24 kV for overhead line

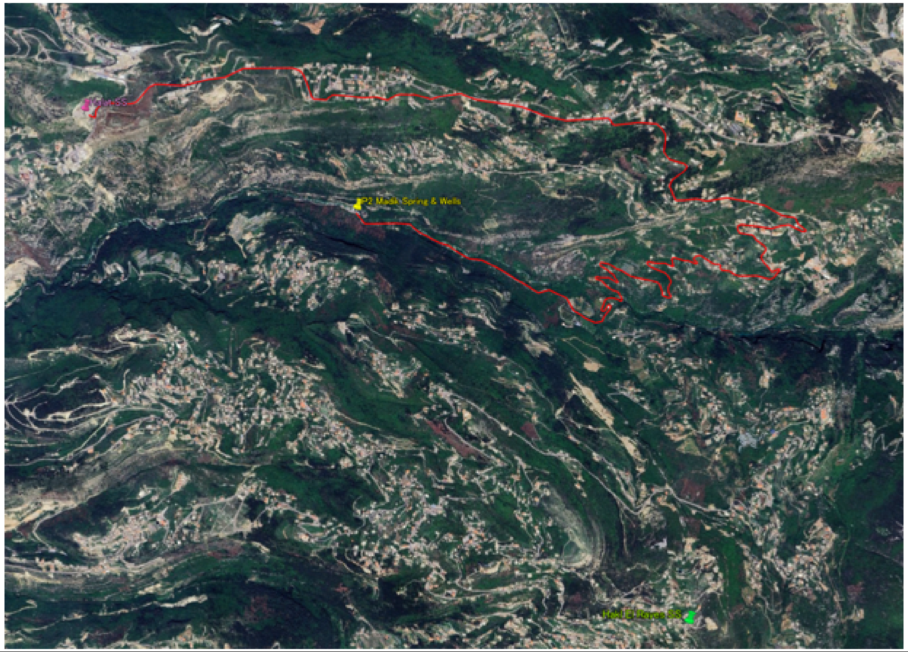
Using the above unit price (60,000US$/km)

	Name	District	Method	Substaion	Length (km)	Unit Cost (USD/km)	Total Cost (US$)
P1	Al Jisr	Tripoli	Overhead Line	Orienge Nassau SS	7.3	60,000	438,000
P2	Majdalaya						
P3	Hawouz Abi Samra						
	Daher Mougher						
	Hawouz El Kobbe						

Cost Estimation (Step2)

※ <u>For Step 2, the length of the dedicated line is estimated using Google Earth, as same as Tripoli.</u>

Plant Name	Jbei WTP Mosfeyeh
Dedicate Line Route	
From To	Amchit S/S - Jbei WTP Mosfeyeh
Line Length	3.3 km

Plant Name	Madik Spring & Wells
Dedicate Line Route	
From To	Halat Substation - Madik Spring & Wells
Line Length	13.1 km

Cost Estimation (Step2)

Plant Name	Naher El Kalb/Mokhada

Dedicate Line Route

From To	Zouk S/S - Naher El Kalb/Mokhada
Line Length	4.7 km

Plant Name	Anterias Saltaneh/Puits

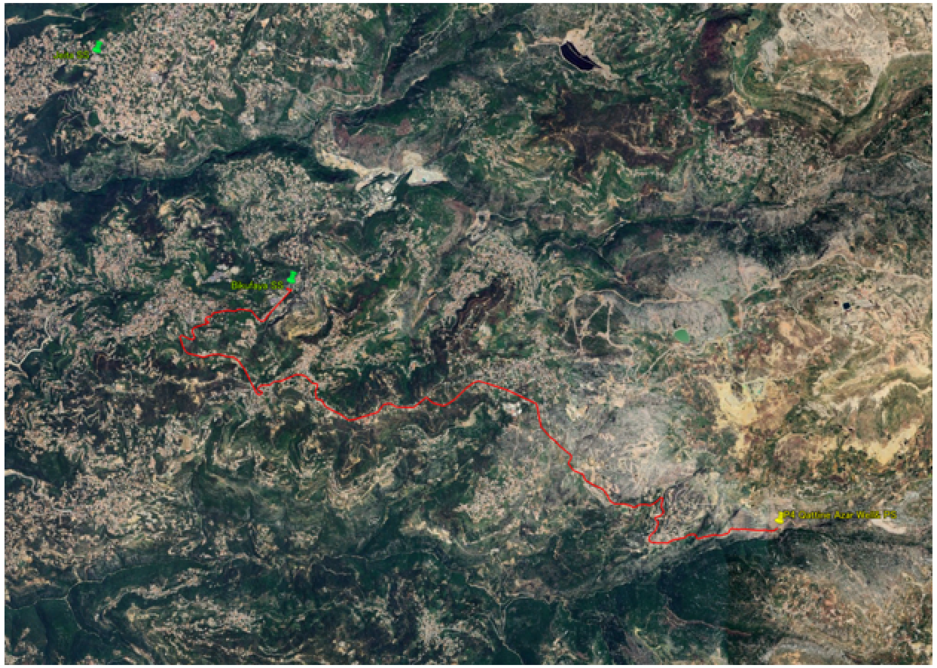
Dedicate Line Route

From To	Bsalim S/S - Antelias Saltaneh/Puits
Line Length	4.4 km

Cost Estimation (Step2)

Plant Name	Qattine Azar Well& PS

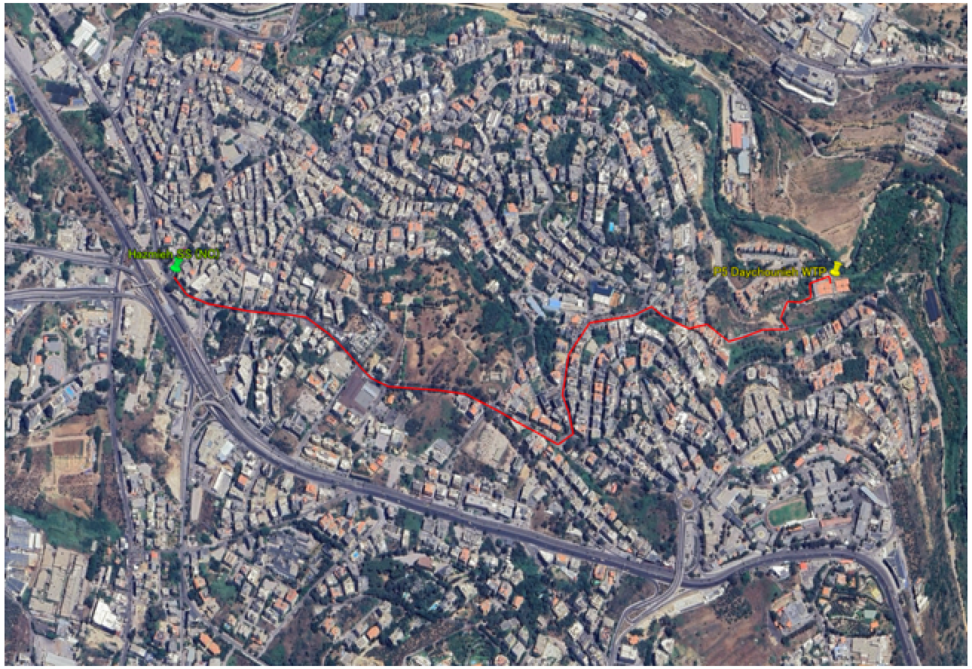
Dedicate Line Route



From To	Bikufaya S/S - Qattine Azar Well& PS
Line Length	17.1 km

Plant Name	Daychounieh WTP

Dedicate Line Route

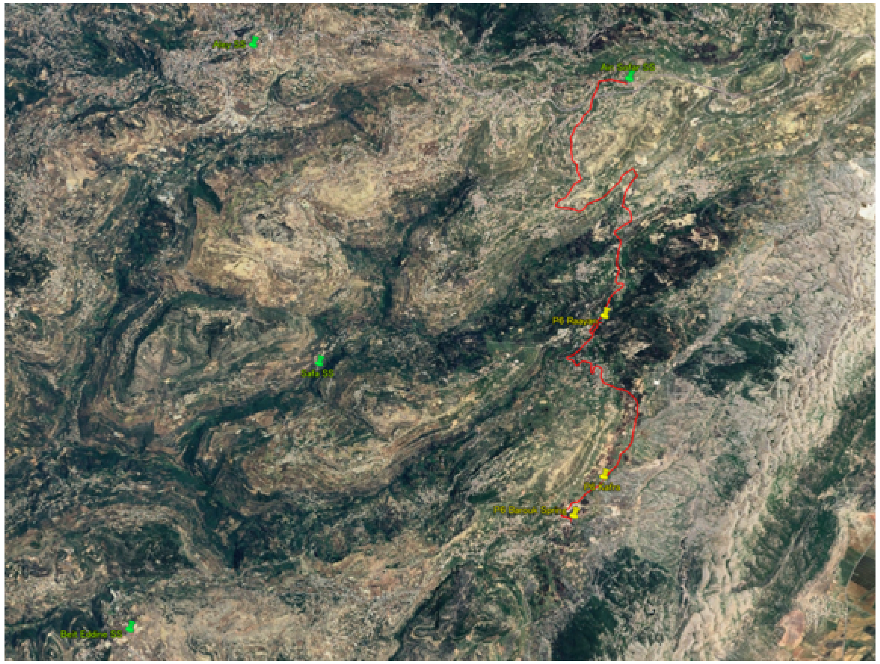


From To	Hazmieh S/S (NC) - Daychounieh WTP
Line Length	2.2 km

Cost Estimation (Step2)

Plant Name	Barouk Spring/Kafra/Raayan

Dedicate Line Route



From To	Ain Sofar S/S - Barouk Spring/Kafra/Raayan
Line Length	18.7 km

Plant Name	Bhamdoun Station

Dedicate Line Route

From To	Aley S/S - Bhamdoun Station
Line Length	5.8 km

Cost Estimation (Step2)

Next, similar to Tripoli, the construction cost was calculated using the construction unit price (60,000 US$/km). The results are shown in the table below.

		Name	District	Substation	Line length (km)	Cost Estimation (US$)
MoEW	P1	Jbeil-Moussfaya	Jbeil	Amchit SS	3.3	198,000
	P2	Madik Spring & Wells	Keserwen	Halat SS	13.1	786,000
	P3-1	Naher El Kalb	El Meten	Zouk SS	4.7	282,000
		Mokhada				
	P3-2	Antelias Saltaneh		Bsalim SS	4.4	264,000
		Antelias Puits				
	P4	Qattine Azar Well & PS	El Meten	Bikufaya SS	17.1	1,026,000
	P5	Daychounieh Water Treatment Plant	Baabda	Hazmieh SS	2.2	132,000
	P6	Barouk Spring	Aley	Saoufar SS	18.7	1,122,000
		Kafra				
		Raayan				
	P7	Bhamdoun Station	Aley	Aley SS	5.8	348,000
		*Dedicated Line Unit Price: 60,000US$/km			69.3	4,158,000

Cost Estimation (Summary)

Finally, the overall result is as follows

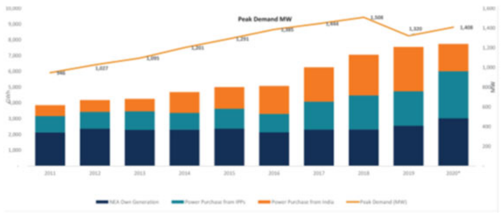
		Name	District	Substation	Line length (km) OHL	Line length (km) UGC	Cost Estimation (US$) 1st Priority	Cost Estimation (US$) 2nd Priority
Tripoli	P1	Al Jisr	Tripoli	Orienge Nassau SS	7.3	-	438,000	-
	P2	Majdalaya						
	P3-1	Hawouz Abi Samra						
	P3-2	Daher Mougher						
	P3-3	Hawouz El Kobbe						
MoEW	P1	Jbeil-Moussfaya	Jbeil	Amchit SS	3.3	-	-	198,000
	P2	Madik Spring & Wells	Keserwen	Halat SS	13.1	-	-	786,000
	P3-1	Naher El Kalb	El Meten	Bsalim SS	4.7	-	-	282,000
		Mokhada						
	P3-2	Antelias Saltaneh		Zouk SS	4.4	-	-	264,000
		Antelias Puits						
	P4	Qattine Azar Well & PS	El Meten	Bikufaya SS	17.1	-	-	1,026,000
	P5	Daychounieh Water Treatment Plant	Baabda	Hazmieh SS	2.2	-	-	132,000
	P6	Barouk Spring	Aley	Saoufar SS	18.7	-	-	1,122,000
		Kafra						
		Raayan						
	P7	Bhamdoun Station	Aley	Aley SS	5.8	-	-	348,000
	P8-1	Bourj Abi Haydar	Beirut	-	-	0.32	44,000	-
	P8-2	Tallet El Khayat		-	-	0.16	22,000	-
					76.6	0.48	504,000	4,158,000
							4,662,000	

Preparation of Future T/C Project

Preparation of Future T/C Project for IEMP 1

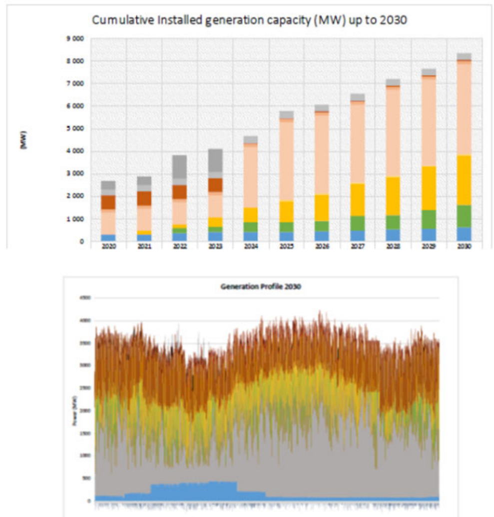
Original plan of Future T/C Project aims to enhance the capacity to formulate IEMP indicating long term “Vision” and “Target” in the power Sector.

Power Demand Forecast

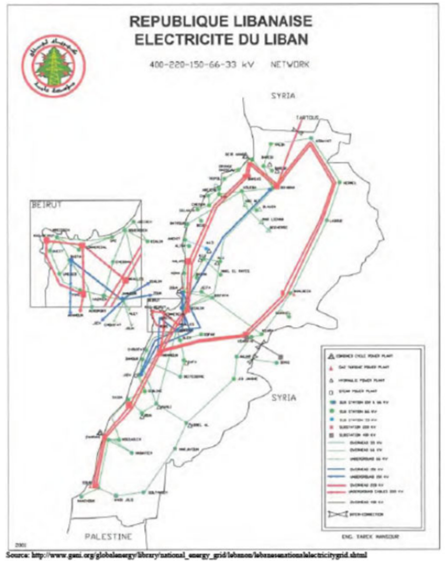


Primary Energy Resources

Power Generation Development Planning



Power System Planning



Economic and Financial Analysis
Environmental and Social Considerations

Integrated Electricity Master Plan

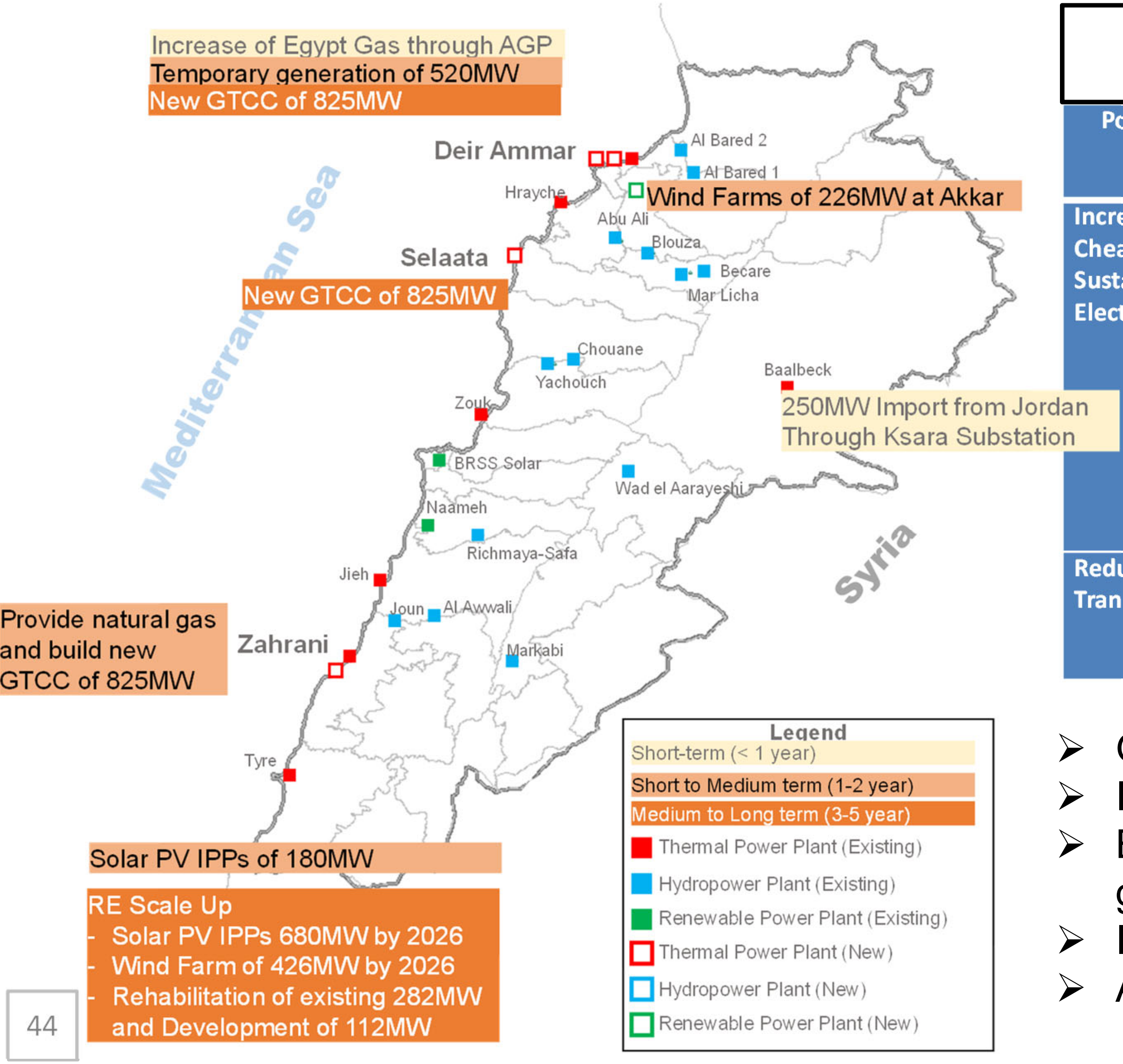
Interviews with EDL and MoEW on Future T/C Project

Following items are confirmed from interviews with EDL and MoEW are;

- JICA Study Team recognized that MoEW and EDL have been struggling with the following three serious external conditions,
  1. *Impact of the financial crisis since 2020*
  2. *Depreciation of the Lebanese currency*
  3. *Affects of explosion at Beirut port in 2020*
- Whilst these challenges are not attributable to MoEW nor to EDL, they significantly affect EDL business operation.
- Particularly, insufficient human resources are critical issues for JICA to effectively implement the originally planned T/C (capacity building).

Based on these consultations, contents of future T/C is considered.

Practical Implementation Plan in Short Term

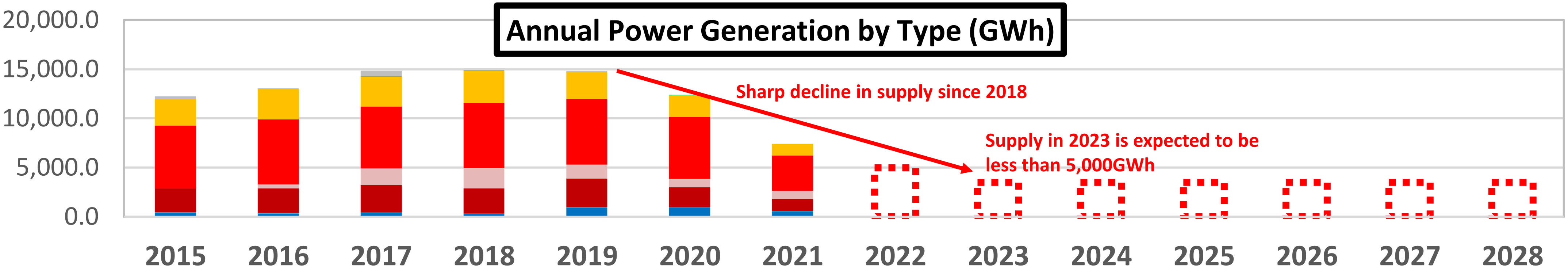


Setting Lebanon’s Electricity Sector on a Sustainable Growth Path

Policy Objective	Short-term (< 1 year)	Short- to Medium-term (1-2 years)	Medium- to Long-term (3-5 years)
Increase Supply of Cheaper, more Sustainable Electricity Supply	• Secure electricity imports from Jordan. • Secure gas imports from Egypt through AGP •	• Provide natural gas to existing plant and build gas-fired combined cycle power plant at Zahrani. • Temporary generation capacity at Deir Amar. • Solar PV IPPs. • Wind Farms.	• Renewable Energy scale-up. • Decommission old plants at Zouk and Jieh. • Build gas-fired combined cycle power plants.
Reduction of Transmission Losses	• Rehabilitation of the National Control Center and EDL main building.	• Undertake planned transmission reinforcement projects.	•

- ➢ Generation and transmission development planning
- ➢ Introduction of renewable energy including DRE
- ➢ Extension of duration of power supply from the national grid
- ➢ Improving performance of the transmission network and
- ➢ Achieving financial sustainability.

Surrounding Situation of Electric Power Sector



External Conditions
(Out of control by EDL and MoEW)

Financial Crisis since 2019

Explosion at Beiruit Port in 2020

Currency Depreciation since 2020

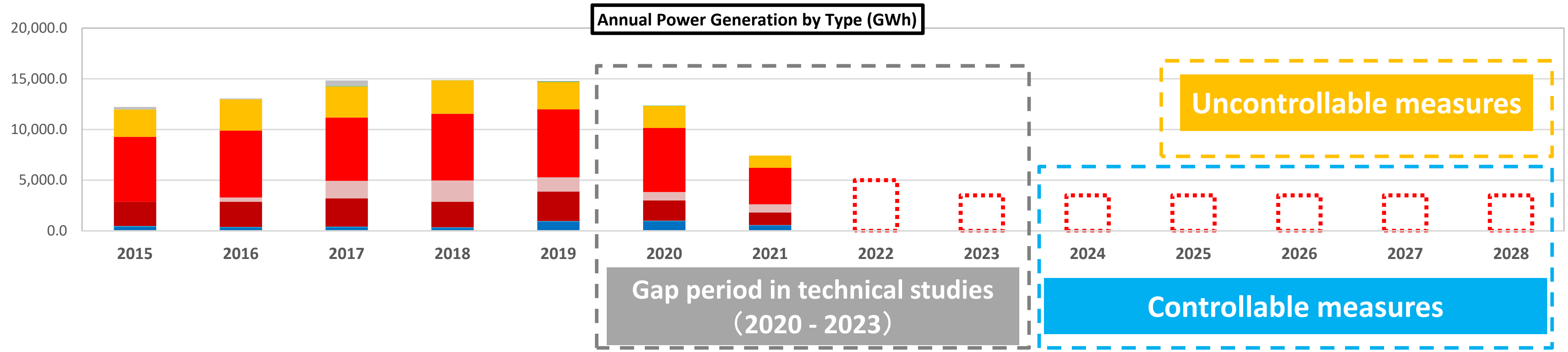
Impacts on Electric Power Sector

- Interruption of hiring new employees due to budget shortage
- Suspension of new investment for electric power facilities
- Suspension of data collection at Load Dispatch Center
- Shortage of supply
- Outflows of staffs

Minor Modifications on T/C Project

Item	Original	Modification
Plan and Target Year	Integrated Electricity Master Plan by 2040	**Blueprint for EDL Reconstruction in short term**
Capacity Development	Plan will be prepared by Lebanese side under the technology transfer of JICA Study Team	Roadmap will be prepared by JICA Study Team and Lebanese side. Technology transfer will ne carried out
Implementation Agency	EDL and MoEW	EDL and MoEW
Project Period	24 months	18 months
Provision of Software	Generation and Transmission Planning Tools	Generation and Transmission Planning Tools

Blueprint for EDL Reconstruction



- It is essential to carry out a baseline survey to fill the gap of technical studies since 2020 due to the difficulties such as financial crisis of Lebanon, effect of explosion at Beirut Port and currency depression as preparatory works for planning.
- The demand and supply model is established involving distributed renewable energy, operation of existing thermal power plants based on the revenue and expenditure situation with the new tariff structure and strategic load allocation with priority.
- As for the direction of development such as generation mix and network configuration in the medium to long term, the basic concepts had been already studied in existing development plans
- New projects are classified into “Uncontrollable” defined as ones which are hard to managed by MoEW and EDL and “Controllable” ones which can be handled.
- Based on these situations, Blueprint for EDL Reconstruction is necessary.

Outline of Future T/C (Proposed by JICA Study Team)

Item	Contents
Project Title	Project for Formulation of Blueprint for EDL Reconstruction
Project Outline	
(1) Overall Goals	To reconstruct financial and institutional capacity of EDL based on formulated blueprint.
(2) Outputs	To formulate Blueprint for EDL Reconstruction in coordination with key stakeholders.
(3) Activities	The Project will carry out the following tasks collaboration between EDL staffs and JICA Experts.
Task 1	Review of the current situation on electricity sector and preparation of the baseline survey for Blueprint for EDL Reconstruction.
Task 2	Formulate institutional capacity strengthening plan of power demand forecast
Task 3	Enhancement of the introduction of distributed renewable energy
Task 4	Economic and financial analysis of EDL
Task 5	Formulate the institutional arrangement plan
Task 6	Formulation the Blueprint for EDL Reconstruction
Counterparts	Implementing Agency :EDL (Électricité du Liban) Supervising Agency :MoEW (Ministry of Electricity and Water)
Project Period	18 months

NEWJEC Kansai Transmission and Distribution